PROCESS CARTRIDGE, ELECTROPHOTOGRAPHIC IMAGE FORMING APPARATUS AND CARTRIDGE MOUNTING METHOD

FIELD OF THE INVENTION AND RELATED ART:

The present invention relates to a process cartridge, an electrophotographic image forming apparatus to which the process cartridge is detachably mountable, and a process cartridge mounting method.

Here, the electrophotographic image forming apparatus (image forming apparatus) is an apparatus which forms an image on a recording material using an electrophotographic image forming process, and examples of the apparatus include an electrophotographic copying machine, an electrophotographic printer (an LED printer, a laser beam printer or the like), an electrophotographic printer type facsimile machine, an electrophotographic printer type word processor and the like.

The process cartridge is a cartridge containing as a unit an electrophotographic photosensitive member and a charging means, developing means or cleaning means, which cartridge is detachably mountable as a unit to the main assembly of the image forming apparatus. another example of the process cartridge includes as a unit an electrophotographic

photosensitive member and at least one of charging means, developing means and cleaning means, wherein said process cartridge is detachably mountable as a unit to the main assembly of the image forming apparatus. a further example of the process cartridge includes an electrophotographic photosensitive drum and at least developing means, and is detachably mountable as a unit to the main assembly of image forming apparatus.

A yet further example of a process cartridge includes a cleaning unit containing as a unit charging means, cleaning means and a photosensitive drum, and a developing unit complaining as a unit developing means and toner to be supplied to developing means. in this case, the cleaning unit and the developing unit are coupled with each other by a coupling member into a process cartridge.

Heretofore, in image forming apparatus forming an image on a recording material using an electrophotographic image forming process, a cartridge system in which the electrophotographic photosensitive member and process means actable on said electrophotographic photosensitive member are constituted into a unit (cartridge) which is detachably mountable to image forming apparatus. with the use of the process cartridge type, the maintenance operation can be carried out in effect by the users

without necessity of relying on serviceman, and therefore, the operativity is improved. For this reason, it is widely used in the image forming apparatus.

However, the size of the process cartridge increases with the increase of the capacity which has been necessitated due to the higher speed demand and the longer service life demand. Further improvement in the operativity is desired.

The heavier process cartridge requires a correct positioning system durable against the weight.

SUMMARY OF THE INVENTION:

Accordingly, it is a principal object of the present invention to provide a process cartridge and an electrophotographic image forming apparatus in which the operativity in the mounting and demounting of a process cartridge relative to the main assembly of the apparatus. It is another object of the present invention to provide a process cartridge, a process cartridge mounting method and an electrophotographic image forming apparatus in which the process cartridge can be positioned in the main assembly of apparatus with high accuracy.

It is a further object of the present invention to provide a process cartridge, a process cartridge mounting method and an electrophotographic

image forming apparatus in which the process cartridge is lowered to a predetermined position in the main assembly of the apparatus.

It is a further object of the present invention to provide a process cartridge, a process cartridge mounting method and an electrophotographic image forming apparatus in which the operativity in the mounting of the process cartridge is improved.

It is a further object of the present invention to provide a process cartridge, an electrophotographic image forming apparatus and a process cartridge mounting method in which the operativity is good, and the positioning accuracy is improved.

These and other objects, features, and advantages of the present invention will become more apparent upon consideration of the following description of the preferred embodiments of the present invention, taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS:

Figure 1 is a vertical sectional view of an electrophotographic image forming apparatus.

Figure 2 is a vertical sectional view of a process cartridge.

Figure 3 is a front view of the process

cartridge.

Figure 4 is a rear view of the process cartridge.

Figure 5 is a perspective view of the process cartridge as seen from diagonally above the top right of the rear end of the process cartridge in terms of the direction in which the process cartridge is mounted.

Figure 6 is a perspective view of the process cartridge as seen from diagonally below the bottom right of the front end of the process cartridge in terms of the process cartridge mounting direction.

Figure 7 is an exploded perspective view of the process cartridge.

Figure 8 is a rough rear view of the process cartridge, with the side cover removed.

Figure 9 is a rough front view of the process cartridge, with the side cover removed.

Figure 10 is a perspective view of a sealing sheet for sealing between a toner container and a developing means holding frame, and components related to the sealing sheet.

Figure 11 is a perspective view of a sealing sheet for sealing between a toner container and a developing means holding frame, and components related to the sealing sheet.

Figure 12 is a perspective drawing for

depicting how the sealing sheet is applied.

Figure 13 is a perspective drawing for depicting how the sealing sheet is applied.

Figure 14 is a perspective drawing for depicting how the sealing sheet is applied.

Figure 15 is a perspective drawing for depicting how the sealing sheet is applied.

Figure 16 is an exploded perspective view of the process cartridge, for showing the sealing sheet for sealing between a toner container and a developing means holding frame in another embodiment of the present invention.

Figure 17 is a vertical sectional view of the process cartridge, for showing the sealing sheet for sealing between a toner container and a developing means holding frame in another embodiment of the present invention.

Figure 18 is an exploded perspective view of a developing apparatus, for describing the structure for connecting a developing means holding frame and a cleaning means holding frame.

Figure 19 is a perspective view of a portion of the developing apparatus.

Figure 20 is an exploded perspective view of the structure for connecting the developing apparatus and cleaning means holding frame.

Figure 21 is a perspective view of the

structure for connecting the developing apparatus and cleaning means holding frame.

Figure 22 is a rear view of the structure for connecting the developing apparatus and cleaning means holding frame.

Figure 23 is an exploded perspective view of the developing means holding frame and side cover, for showing their relationship.

Figure 24 is a perspective view of the couplings for driving the photosensitive drum.

Figure 25 is a rear view of the couplings for driving stirring members.

Figure 26 is a rear view of the couplings for driving stirring members.

Figure 27 is a diagram of the system for driving the process cartridge.

Figure 28 is a front view of a cooling means of the process cartridge.

Figure 29 is a front view of the cooling means of the process cartridge.

Figure 30 is a sectional view of a gear with an impeller at a plane A-A in Figure 31.

Figure 31 is a perspective view of the gear with an impeller.

Figure 32 is a perspective view of the gear with an impeller at a plane B-B in Figure 31.

Figure 33 is a vertical sectional view of an

example of a conventional process cartridge.

Figure 34 is a front view of a portion of the process cartridge, with the side cover removed.

Figure 35(a) is a perspective rear view of a connecting member, and Figure 35(b) is a perspective front view of the connecting member.

Figure 36 is an exploded perspective view of the development roller, development roller bearing, and components adjacent thereto, of the process cartridge.

Figure 37 is a sectional view of the structure for supporting the development roller and photosensitive drum, at one of the longitudinal ends of the process cartridge.

Figure 38 is a perspective view of the connecting member in another embodiment of the present invention.

Figure 39 is a front view of the cartridge mounting portion of an image forming apparatus.

Figure 40 is a front view of the image forming apparatus, for showing the manner in which the process cartridge is mounted into or dismounted from the main assembly of the image forming apparatus.

Figure 41 is a front view of the image forming apparatus, for showing the manner in which the process cartridge is mounted into or dismounted from the main assembly of the image forming apparatus.

Figure 42 is a perspective view of the cartridge mounting portion of the image forming apparatus main assembly.

Figures 43(L), 43(M), and 43(N) are plans for showing the manner in which the process cartridge is inserted into the image forming apparatus main assembly.

Figures 44(H), 44(I), and 44(J) are sectional drawings for showing the relationship among the guiding portion of the process cartridge, and the vertical movement lever and guide rail of the image forming apparatus main assembly.

Figures 45(P), 45(Q), and 45(R) are plans for showing the manner in which the process cartridge is inserted into the image forming apparatus main assembly, in another embodiment of the present invention.

Figure 46 is a side view of the vertical movement lever and process cartridge, for showing the loci of the essential portions of the process cartridge, in the cartridge mounting portion.

Figure 47 is a plan view of the process cartridge.

Figure 48 is a bottom view of the process cartridge.

DESCRIPTION OF THE PREFERRED EMBODIMENTS:

The preferred embodiments of the present invention will be described with reference to Figures 1 - 9. In the following embodiments of the present invention, the longitudinal direction means such a direction that is perpendicular to the direction in which recording medium is conveyed, and that is parallel to the surface of the recording medium. The top and bottom surfaces of a process cartridge means the top and bottom surfaces of the process cartridge which has been properly mounted in the main assembly of an image forming apparatus.

(Description of process Cartridge and Main Assembly of Image Forming Apparatus)

Figure 2 is a sectional view of a process cartridge in accordance with the present invention, at a plane perpendicular to the longitudinal direction, and Figure 1 is a sectional view of an image forming apparatus in accordance with the present invention, at a plane perpendicular to the longitudinal direction. This process cartridge comprises an electrophotographic photosensitive member, and a plurality of processing means which act on the electrophotographic photosensitive member. As for the processing means, there are a charging means for charging the peripheral surface of the electrophotographic photosensitive member, a developing means for developing an electrostatic

latent image formed on the electrophotographic photosensitive member, and a cleaning means for removing the developer remaining on the peripheral surface of the electrophotographic photosensitive member.

Referring to Figure 2, in the process cartridge 15 in this embodiment, a charging member 12 as a charging means, a development roller as a developing means, a development blade as a developing means, and a cleaning member 14 as a cleaning means, are positioned around the electrophotographic photosensitive drum 11. These components are integrally covered with a housing, forming the process cartridge 15 which is removably mountable in the main assembly 27 of an image forming apparatus (which hereinafter will be referred to as an apparatus main assembly). The charging member 12 is a charge roller, which comprises a metallic core and a layer of rubber wrapped around the metallic core. The electrical resistance of the rubber layer is in the medium range. The cleaning member 14 comprises a rubber blade placed in contact with the peripheral surface of the photosensitive drum 11 to scrape away the toner remaining on the photosensitive drum 11 after image transfer, and a metallic plate to which the rubber blade is fixed.

Referring to Figure 1, this process cartridge

15 is mounted in an electrophotographic image forming apparatus C to be used for image formation. In an image forming operation, a sheet S is conveyed by a conveying roller 7 from a sheet cassette 6 mounted in the bottom portion of the apparatus main assembly. In synchronism with the conveyance of the sheet S, a latent image is formed by selectively exposing the peripheral surface of the photosensitive drum 11 with the use of an exposing apparatus 8. Thereafter, the toner stored in a toner container 16 is coated in a thin layer on the peripheral surface of the development roller 18 by the development blade 26, while being triboelectrically charged. Then, the toner on the development roller 18 is supplied to the peripheral surface of the photosensitive drum 11, in accordance with the latent image, by applying development bias to the development roller 18. As a result, a toner image is formed on the peripheral surface of the photosensitive drum 11. This toner image is transferred onto the sheet S as recording medium, which is being conveyed, by the application of bias voltage to the transfer roller 9. Then, the sheet S is conveyed to a fixing apparatus 10, in which the toner image is fixed to the sheet S. Thereafter, the sheet S is discharged into a sheet delivery portion 2 at the top of the apparatus main assembly, by a discharge roller 1.

On the other hand, after the image transfer, the toner remaining on the photosensitive drum 11 is removed by the cleaning member 14, and is moved inward of a removed toner bin 5 by a removed toner moving member 115.

(Structure of Process Cartridge Frame)

Figures 3 - 9 are drawings for showing the structure of the process cartridge frame. Figure 7 is a drawing which shows the components of the process cartridge prior to their assembly. Figures 3 - 6 are drawings of the process cartridge after its assembly. The process cartridge 15 comprises three frames: a cleaning means holding frame 13, which integrally supports the photosensitive drum 11, charging member 12, and cleaning member 14; a developing means holding frame 17 (which may be referred to as a development frame) which integrally supports the development roller 18, and a development blade (which is not shown in Figure 7, and is shown in Figure 2, being designated by a referential code 26); and a developer holding frame 16 which constitutes a developer container 16h for holding developer (which hereinafter will be referred to as toner). The developer holding frame 16 is provided with a cover 45, which is attached to the bottom of the developer holding frame 16 and will be referred to as a bottom cover. In addition, the process cartridge 15 comprises a pair of

end covers 19 and 20, which are fixed to the longitudinal ends, one for one, of both the cleaning means holding frame 13 and developer holding frame 16. The developing means holding frame 17 is supported by the cleaning means holding frame 13. Hereinafter, the frame which supports the photosensitive drum 11 may be referred to as a drum frame.

As described above, the process cartridge 15 has the bottom cover 45, which is attached to the process cartridge 15, at a location which will be below the development roller 18 as a developing member, and a development blade 26 as a developing member after the mounting of the process cartridge 15 in the apparatus main assembly 27. It constitutes a part of the external wall of the process cartridge 15. One end of the bottom cover 45 in terms of the longitudinal direction is connected to the end cover 19, or the end cover on the rear end of the process cartridge 15 in terms of the process cartridge insertion direction, and the other end of the bottom cover 45 is connected to the end cover 20, or the end cover on the front end of the process cartridge 15 in terms of the process cartridge insertion direction.

Referring to Figure 3, the rear end cover 19 has a second handle 29, which is grasped by an operator when the process cartridge 15 is mounted into or dismounted from the apparatus main assembly 27 by

the operator. The process cartridge 15 is mounted into or removed from the apparatus main assembly 27 in the direction parallel to the longitudinal direction of the photosensitive drum 11. More specifically, when the process cartridge 15 is mounted into the apparatus main assembly 27, it is inserted all the way into the apparatus main assembly 27 in the longitudinal direction, and then, is lowered into the apparatus main assembly 27, whereas when it is removed from the apparatus main assembly 27, it is first moved upward and then is pulled out in the longitudinal direction.

The rear end cover 19 is provided with a hole 19a, through which a shaft 22a1, the axial line of which coincides with the that of the shaft which bears the photosensitive drum, extends outward. The shaft 22a1 is a part of a bearing member 22a with which one of the longitudinal ends of the photosensitive drum 11 is supported by the cleaning means holding frame 13. It is accurately positioned relative to the apparatus main assembly 27 as the process cartridge 15 is mounted into the apparatus main assembly 27. More specifically, first, the process cartridge 15 is inserted straight into the apparatus main assembly 27 as far as possible, and then, is lowered into the apparatus main assembly 27. As the process cartridge 15 is lowered, the shaft portion (positioning member)

22al integral with the drum shaft engages into the positioning recess (which will be described later) of the apparatus main assembly 27. While the process cartridge 15 is inserted into, or pulled out of, the apparatus main assembly 27, the process cartridge 15 is supported by the apparatus main assembly 27 at the guide portions 19g and 20g.

Referring to Figure 5, the developer holding frame 16 is provided with a first handle 30, which is on the top surface of the process cartridge 15. Here, the top surface of the process cartridge 15 means a surface of the process cartridge 15, which faces upward after the mounting of the process cartridge 15 into the apparatus main assembly 27. The first handle 30 is a handle which is grasped by an operator when the process cartridge 15 is carried. It folds into the recess 16e in the top surface of the developer holding frame 16. It is attached to the developer holding frame 16 by its base portions 30a with the use of pins (unshown) parallel to the longitudinal direction. When the first handle 30 is used, it is rotated about the pins to the position at which it becomes upright relative to the top surface of the process cartridge 15.

Referring to Figures 2 and 5, the cleaning means holding frame 13 is provided with an exposure opening 13, through which the light, which is

projected from the exposing apparatus 8 of the apparatus main assembly 27 while being modulated with image formation information, is allowed to enter the process cartridge 15 to expose the photosensitive drum 11.

Referring to Figures 4 and 7, the front end cover 20 is provided with a first hole 20a and a second hole 20e. In the first hole 20a, a first coupling 105a is fitted, which is a first driving force receiving portion for receiving the driving force for rotating the photosensitive drum 11 from the apparatus main assembly 27 after the mounting of the process cartridge 15 into the apparatus main assembly 27. The first coupling 105a as a driving force receiving portion is an integrally formed part of a flange 11a shown in Figure 7. The flange 11a is fixed to one of the longitudinal ends of the photosensitive drum 11. In the second hole 20e, a second coupling 106a as a second driving force receiving portion is fitted, which receives, from the apparatus main assembly 27, the driving force for rotating stirring members 113, 114, and 123 (Figure 2) as toner moving members for sending out the toner stored in the developer container 16h of the developer holding frame 16 after the mounting of the process cartridge 15 into the apparatus main assembly 27.

The details of the developing means holding

frame 17 will be given later.

The end covers 19 and 20 are large enough to virtually perfectly cover the corresponding ends of the process cartridge 15 in the longitudinal direction (large enough to match in size and shape the cross section of the process cartridge 15 at a plane perpendicular to the longitudinal direction), and are located at the ends of the process cartridge 15 in the longitudinal direction, one for one. The end covers 19 and 20 each extend across the longitudinal ends of the cleaning means holding frame 13 and developer holding frame 16, and are fixed to the cleaning means holding frame 13 and developer holding frame 16, thereby holding the cleaning means holding frame 13 and 16 together.

The positions of the end covers 19 and 20 are fixed relative to the cleaning means holding frame 13 and developer holding frame 16 so that the centers of the holes 19a and 20a shown in Figure 7 align with the axial line of the photosensitive drum 11 supported by the cleaning means holding frame 13. On the rear end cover 19 side shown in Figure 7, the bearing member 22a is pressed into the hole 13a of the cleaning means holding frame 13, and small screws 49 are put through the flange 22a2 and are screwed into the cleaning means holding frame 13. The bearing member 22a comprises the flange 22a2 and the shaft 22a1

integrally formed with the flange 22a2. The shaft 22a1 is put through the hole 13a, and then, the end of the shaft 22a1 is slid into the center hole of the flange 11b. To one of the longitudinal ends of the photosensitive drum 11, the flange 11b is immovably fitted. Since the position of the rear end cover 19 relative to the cleaning means holding frame 13 is fixed by the outward shaft 22a1 of the bearing member 22a, the rear end cover 19 is accurately positioned relative to the photosensitive drum 11. The positioning portion 19b, that is, one of the joggles of the rear end cover 19, which is positioned as far as possible from the photosensitive drum 11, is fitted in the positioning portion 13b, that is, one of the holes of the side wall 13c of the cleaning means holding frame 13. With this arrangement, the rear end cover 19 is prevented from rotating about the axial line of the photosensitive drum 11. The rear end cover 19 is fixed to the side wall 13c of the cleaning means holding frame 13, that is, one of the end walls of the cleaning means holding frame 13 in terms of the longitudinal direction.

The developer holding frame 16 is provided with cylindrical positioning portions 16a and 16b, which are on the side wall 16d, that is, one of the end walls of the developer holding frame 16 in terms of the longitudinal direction. The positioning

portions 16a and 16b project in the longitudinal direction. They are fitted in the positioning portions 19c and 19d, which are holes of the rear end cover 19. With this arrangement, the positions of the developer holding frame 16 and rear end cover 16 relative to each other are fixed. The developer holding frame 16 and rear end cover 16 are fixed to each other. The other end cover, or the front end cover 20, is accurately positioned relative to the developer holding frame 16 and 13, and is fixed to them, in the same manner as is the rear end cover 19. That is, the shaft of the bearing member 22b fixed to the cleaning means holding frame 13 by being pressed into the cleaning means holding frame 13 is fitted in the hole 20a of the front end cover 20, in such a manner that a portion of the bearing member 22b extends outward from the front end cover 20. The bearing members 22 (22a and 22b) double as members for accurately positioning the process cartridge 15 relative to the apparatus main assembly 27; in other words, the bearing members 22 are cylindrical members for fixing the position of the process cartridge 15. The position of the developing means holding frame 17 relative to other components is fixed by a method which will be described later.

(Method for Connecting Frames)

The cartridge frame essentially comprises the

cleaning means holding frame 13, developer holding frame 16, developing means holding frame 17, end cover 19, and end cover 20.

The cartridge frame is temporarily assembled prior to its permanent assembly. In the temporary assembly of the cartridge frame, the shaft 22a1 projecting from the cleaning means holding frame 13 is put through the hole 19a of the rear end cover 19; the positioning portion (cylindrical joggle) 19b of the rear end cover 19 is put through the positioning hole 13b of the side wall of the cleaning means holding frame 13; and the positioning portions 16a and 16b of the end wall of the developer holding frame 16, are put through the positioning portions (holes) 19c and 19d of the rear end cover 19. Also on the front end cover 20 side, the front end cover 20, cleaning means holding frame 13, and developer holding frame 16 are joined with each other in the same manner as on the rear end cover 19 side. Since these components can be temporarily assembled as described, they are easy to handle or put together before they are permanently fixed to each other.

In order to fix the rear end cover 19 to the cleaning means holding frame 13 and developer holding frame 16, first small screws 28 are put through the positioning portions 19c and 19d and screwed into the positioning portions 16a and 16b. Also, an additional

small screw 28 is put through the hole 19h of the rear end cover 19 and screwed into the hole of the joggle 13e of the cleaning means holding frame 13. The positioning portions 19c and 19d, and hole 19h, are step holes, the outward sides of which are smaller in diameter. The smaller diameter portions of the holes are large enough in diameter for the screws 28 to be put through, but are smaller in diameter than the positioning portions 16a and 16b, and the joggle 13e. The cleaning means holding frame 13 and developer holding frame 16 are held together by the front end cover 20 in the same manner as they are by the rear end cover 19.

Incidentally, the cleaning means holding frame 13 and developer holding frame 16 may be held together by the end covers 19 and 20 with the use of resin. In such a case, the end covers 19 and 20, cleaning means holding frame 13, and developer holding frame 16 are provided with resin flow paths, which must be formed along the joining edges of the end covers 19 and 20, cleaning means holding frame 13, and developer holding frame 16, when these components are formed. Then, melted resin is poured into the resin flow paths from the gate of a fixing jig, which is different from the jig used for forming the end covers 19 and 20, through a resin pouring path set up between the gate and the resin flow paths. The poured melted

resin is allowed to solidify in the resin flow paths to keep the cleaning means holding frame 13 and developer holding frame 16 together by the end covers 19 and 20. Before the pouring of melted resin, the process cartridge 15 is temporarily assembled in advance, and placed in the fixing jig used for joining the cleaning means holding frame 13 and developer holding frame 16 by the end covers 19 and 20 with the use of resin.

The developer holding frame 16 and developing means holding frame 17 are provided with a developer supplying hole 16c (Figure 2) and a developer receiving hole 17b, respectively, for supplying toner from the developer holding frame 16 to development roller 18. The developer holding frame 16 and developing means holding frame 17 are connected to each other, with the interposition of a flexible seal 21 (Figure 7), in such a manner that the aforementioned holes 17b and 16c form a through hole between the two frames 16 and 17. The position of the developer holding frame 16 is fixed relative to the end covers 19 and 20, whereas the position of the developing means holding frame 17 is fixed relative to the cleaning means holding frame 13. Therefore, a certain amount of gap must be provided between the developing means holding frame 17 and developer holding frame 16 because it is possible that the two

frames may have dimensional errors. The position of the process cartridge 15 relative to the apparatus main assembly 27 is fixed as the position of the cleaning means holding frame 13 relative to the cartridge mounting portion of the apparatus main assembly 27 is fixed as the process cartridge 15 is inserted into the apparatus main assembly 27.

With the provision of the above described structural arrangement, even if the process cartridge 15 is increased in developer capacity by increasing the size of the developer container 16h, the increase does not adversely affect the development roller 18, because the load from the toner applies to the covers 19 and 20 and the development roller 18 is supported by the developing means holding frame 17. Therefore, it does not occur that unnecessary load is exerted upon the photosensitive drum 11. As a result, quality images can be consistently obtained.

(Method for Attaching Flexible Seal to Developing Means Holding Frame and Developer Holding Frame)

In this embodiment, the process cartridge 15 is structured so that the joint between the developing apparatus D and developer holding frame 16 remains sealed. More specifically, the flexible seal 21 is folded in half, and the two halves of the flexible seal 21 are pasted to each other, forming a sealing member in the form of a bellow, and this bellows-like

sealing member is pasted to the developing apparatus D and developer holding frame 16. The flexible seal 21 is attached to the developer holding frame 16 with the interposition of a backing plate 33 as a connecting member. The flexible seal 21 in this embodiment is no more than 1 mm in thickness. However, the thickness of the flexible seal 21 may be more than 1 mm as long as a material which does not reduce the flexibility of the flexible seal 21 when the flexible seal 21 is folded in the form of bellows is selected as the material for the flexible seal 21.

Next, referring to Figures 10 and 11, a method for attaching the flexible seal 21 will be described. Referring to Figure 10, the flexible seal 21 is provided with first and second hole 21e and 21f. The first hole 21e is the same or larger in size than the hole 33b of the backing plate 33. The second hole 21f is the same or larger in size than the developer receiving hole 17b of the developing means holding frame 17.

The flexible seal 21 is adhered to the backing plate 33 and developing means holding frame 17 by first and second adhering portions 21k and 21m, respectively, that is, the surrounding edges (hatched portions in Figure 10) of the holes 22e and 22f, so that the holes 22e and 22f align with the hole 33 of the backing plate 33 and the toner receiving hole 17b

of the developing means holding frame 17. As a result, the first hole 21 e of the flexible seal 21 is connected to the developer receiving hole 17b of the developing means holding frame 17, forming a through hole, and the second hole 21f of the flexible seal 21 is connected to the hole 33b of the backing plate 33, forming a through hole, as shown in Figure 11.

In this embodiment, the developer holding frame 16, developing means holding frame 17, backing plate 33, and flexible seal 21 are thermally welded to each other by a heat seal method, an impulse seal method, or the like. However, they may be bonded by ultrasonic welding, adhesive, adhesive tape, or the like.

Next, referring to Figure 11, after being pasted to the developing means holding frame 17 and backing plate 33, the flexible seal 21 is folded in the direction indicated by an arrow mark so that the developer receiving hole 17b and the hole 33 of the backing plate 33b align with each other, with the interposition of the flexible seal 21 between the developing means holding frame 17 and backing plate 33. As a result, the flexible seal 21 is shaped like a bellows (or a pouch). Then, the mutually facing halves of the flexible seal 21 are joined to each other by their edges 21d (hatched portions), sealing between the developing means holding frame 17 and

backing plate 33. Also in this case, a thermal welding method such as a heat seal method or an impulse seal method, ultrasonic welding, adhesive, adhesive tape, or the like, may be used.

Next, the backing plate 33 is attached to the developer holding frame 16. In this case, a portion of the backing plate 33 is not welded or glued to the developer holding frame 16 so that a developer seal can be passed through between the developer holding frame 16 and backing plate 33.

In this embodiment, the backing plate 33 is welded by the portion 33a; the portion correspondent to the area across which the toner sealing member 2 25 presses upon the developer seal 24 is not welded. The portion 33a is one of the edges of the backing plate 33 in the longitudinal direction, that is, one of the edges which extend in the width direction, or the direction perpendicular to the longitudinal direction.

With the provision of the above described structural arrangement, in other words, since the flexible seal 21 as a sealing member forms a pouch or a bellows by being folded and welded, the resistance to the change in the gap between the mutually facing surfaces of the developer holding frame 16 and developing means holding frame 17, which occurs as the gap changes, is extremely small. Further, the interposition of the flexible seal 21 between the

backing plate 33 and developing means holding frame 17 makes it possible to attach the backing plate 33 in a manner to cover the developer seal 24, and also to attach the toner sealing member 25 to the backing plate 33 in a manner to keep sealed the gap through which the developer seal 24 is passed. As a result, toner leakage is prevented.

Further, the provision of the backing plate 33 makes it possible to simplify the shape of a welding table necessary for welding, compared to a structural arrangement in which a sealing member in the form of a sheet is directly pasted to the developer holding frame 16.

Further, the provision of the backing plate 33 makes it possible to unitize the flexible seal 21 with the developing means holding frame 17, thereby making it easier to attach the flexible seal 21 to the developer holding frame 16.

Next, another method for attaching the flexible seal 21 to the developing means holding frame 17 and developer holding frame 16 will be described.

In this case, the flexible seal 21 is no more than 0.1 mm in thickness. It is a single layer sheet, and is kept on a backing sheet until it is used. Using a single layer sheet as the material for the flexible seal 21 makes it possible to render the flexible seal 21 less rigid.

Referring to Figure 12, the flexible seal 21 in this case comprises a flexible layer 21a and a backing sheet 21b which is more rigid than the layer 21a. The layer 21a is formed of polyethylene-terephthalate, polypropylene, biaxial orientation Nylon, heat seal member, ester resin, ethylene vinyl acetate, polyurethane resin, polyester resin, olefin resin, or the like.

Next, a method for forming the flexible seal 21 into a bellows will be described.

Referring to Figure 12, a jig 31 for holding the flexible seal 21 is provided with a plurality of holes 31a for holding the flexible seal 21 by suction. These holes 31 a are connected to an unshown vacuum pump. The flexible seal 21 is held to the holding jig 31, with the layer 21a facing the holes 31a, as shown in Figure 13. The flexible seal 21 may be electrostatically held to the holding jig 31 by charging the surface of the holding jig 31. With the flexible seal 21 held to the holding jig 31, the backing sheet 21b, or the second layer of the flexible seal 21, is peeled as shown in Figure 14, leaving only the layer 21a (actual seal 21) on the holding jig 31.

Also referring to Figure 12, the holding jig 31 is provided with a heat generating member 32 for impulse sealing. Next, referring to Figure 15, after the removal of the backing sheet 21b, the layer 21a of

the flexible seal 21 held by the holding jig 31 is pressed onto the backing plate 33 and developing means holding frame 17. Next, with the layer 21a of the flexible seal 21 being pressed onto the backing plate 33 and developing means holding frame 17, electrical current is briefly flowed through the heat generating member 32 to generate heat, and then, the layer 21a of the flexible seal 21 is allowed to cool. As a result, the layer 21a of the flexible seal 21 becomes welded to the backing plate 33 and developing means holding frame 17. Thereafter, the vacuum pump is stopped, and the holding jig 31 is raised to be moved away from the layer 21a of the flexible seal 21 having become welded to the developing means holding frame 17 and backing plate 33. The backing plate 33 functions as a part of the developer holding frame 16. In other words, in reality, the hole 33b of the backing plate 33 becomes the hole of the developer holding frame 16.

The flexible seal 21 (layer 21a) is adhered to the backing plate 33 and developing means holding frame 17 in such a manner that the surrounding edges of the holes 21e and 21f of the flexible seal 21 are adhered to the surrounding edge of the hole 33b of the backing plate 33, and the surrounding edge of the developer receiving hole 17b of the developing means holding frame 17, respectively.

As a result, the flexible seal 21 (layer 21a)

is welded to the developing means holding frame 17 and backing plate 33 as shown in Figure 11. Then, the flexible seal 21 is folded in the direction indicated by the arrow mark in Figure 11, so that the first and second holes 21e and 21f face each other. Then, the mutually facing halves of the flexible seal 21 are joined to each other by their edges 21d (hatched portions), forming a pouch which functions like bellows. The flexible seal 21 may be folded so that the resultant pouch will be shaped like accordion bellows with a plurality of folds.

In this embodiment, ester film is used as the material for the layer 21 a of the flexible seal 21. However, hot melt film such as film of copolymer of ethylene and vinyl acetate or the like may be used.

Further, in this embodiment, the actual flexible seal 21, or the layer 21a, is formed of single layer film. Therefore, if a heat seal method, in which heat is continuously applied, is used, it is possible that the layer 21a of the flexible seal 21 will be welded to the heating portion. Thus, the flexible seal 21 should be welded by an impulse seal method in which the heating, cooling, and holding processes can be carried out in a short time.

In addition, ultrasonic welding, in which heat is instantaneously generated, or adhesive, adhesive tape, or the like, which does not involve

heat, may be used.

With the provision of the above described structural arrangement, even if the layer 21a of the flexible seal 21 is extremely thin, and is difficult to paste in a wrinkle free manner, it can be adhered to a target area while holding a proper shape by being supported by the backing sheet which is removed after the layer 21a is adhered.

Incidentally, a flexible seal 21, which comprises a plurality of layers, may be used in place of the above described flexible seal 21 in which the actual flexible seal layer 21a is formed of single layer film. Also in such a case, the above described method for attaching the flexible seal 21 can be used.

Next, the backing plate 33 is attached to the developer holding frame 16. At this stage, a portion of the backing plate 33 is not welded or adhered to the developer holding frame 16, being left unattached thereto, so that the developer seal 24 can be passed through between the backing plate 33 and developer holding frame 16.

Referring to Figure 7, in this embodiment, the areas 33a are welded, and the area across which the toner sealing member 25 presses upon the developer seal 24 is not welded.

The toner sealing member 25 is an elastic member formed of felt or the like material. It is a

long and narrow member and is attached to the backing plate 33, along the edge of one of the longitudinal ends of the backing plate 33, extending in the width direction of the backing plate 33. It is pasted to the bottom surface of the recess 33c in the backing plate 33 (Figure 8).

With the provision of the above described structural arrangement, even if the gap between the mutually facing surfaces of the developer holding frame 16 and developing means holding frame 17 fluctuates, the resistance which occurs as the developing means holding frame 17 is displaced is extremely small, because the flexible seal 21 is folded in the shape of a pouch or bellows, and is formed of very thin flexible film.

(Other Examples of Sealing Member for Airtightly Sealing between Developing Means Holding Frame and Toner Holding Frame)

Figure 16 is an exploded perspective view of a process cartridge, for describing another example of a sealing member. Figure 16 is a simplified version of Figure 7, except that the sealing member in Figure 16 is different from that in Figure 7.

Figure 17 is a sectional view of a process cartridge at a plane perpendicular to the longitudinal direction of the process cartridge.

A flexible member 21i is in the form of a

plate, and is formed of flexible material such as foamed synthetic resin (for example, foamed urethane), rubber with a relatively low level of hardness, silicone, or the like. It is provided with a hole 21j, which aligns with the developer receiving hole 17b of the developing means holding frame 17, and the developer supplying hole 16c of the developer holding frame 16, as the flexible member 21i is mounted. The hole 21j of the flexible member 21i is approximately the same in size as the holes 17b and 16c. The flexible member 21i is pasted to one or both of the mutually facing surfaces of the developing means holding frame 17 and developer holding frame 16, except across the portion correspondent to the area through which the developer seal 24 is passed when it is pulled out of the process cartridge 15.

The thickness of the flexible member 21i before the process cartridge is assembled is greater than the distance between the mutually facing surfaces of the developing means holding frame 17 and developer holding frame 16, in particular, between the portion 17g surrounding the developer receiving hole 17b of the developing means holding frame 17, and the portion 17f surrounding the developer supplying hole 16c of the developer holding frame 16, after the process cartridge is assembled.

Therefore, in the process cartridge 15 having

been assembled as shown in Figure 17, the flexible sheet 21i remains compressed by the mutually facing surfaces 17g and 16f of the developing means holding frame 17 and developer holding frame 16, respectively. The reactive force generated as the flexible sheet 21i is compressed acts as such force that presses the spacer rings 18b of the development roller 18 upon the photosensitive drum 11. Therefore, it is desired that the resiliency of the flexible sheet 21i is rendered as small as possible.

The employment of this flexible sheet 21i makes it possible to eliminate the need for the backing plate 33 described with regard to the preceding method for sealing between the developer holding frame 16 and developing means holding frame 17, and also, the flexible sheet 21i is easier to apply than the flexible seal 21.

(Developer Seal)

The developer seal is extended from one end of the developer supplying hole 16c of the developer holding frame 16 to the other to seal the hole 16c, and then, is folded back and doubled back beyond the starting point as shown in Figure 7. Prior to the application of the developer seal 24, the stirring members 113, 114, and 123 are assembled into the developer holding frame 16. After the application of the developer seal 24, toner is filled into the

developer holding frame 16 through the toner filling hole 16g. After the filling, a toner cap 37 is pressed into the toner filling hole 16g.

To summarize the description of the sealing member given above, the developing means holding frame 17 and developer holding frame 16 are connected by the flexible seal 21, which is pasted to the developing means holding frame 17 and backing plate 33.

The flexible seal 21 is provided with the first and second holes 21f and 21e, which provide a passage, or a through hole, between the developer holding frame 16 and developing means holding frame 17 as the flexible seal 21 is folded. One end of the thus provided through hole faces the developer supplying hole 16c of the developer holding frame 16 through the hole 33b of the backing plate 33, and the other end of the through hole faces the developer receiving hole 17b of the developing means holding frame 17. The developer supplying hole 16c is a hole through which the toner stored in the developer storing portion 16h of the developer holding frame 16 is conveyed toward the development roller 18 as a developing member. The developer receiving hole 17b is a hole through which toner is received into the developing means holding frame 17 after passing through the developer supplying hole 16c. The flexible seal 21 is pasted to the backing plate 33 by

the surrounding edge of one end of the above described through hole, and is pasted to the developing means holding frame 17 by the surrounding edge of the other end of the through hole. In other words, the first hole 21e, or one end of the above described through hole, faces the developer receiving hole 17b of the developing means holding frame 17, and the second hole 21f, or the other end of the through hole 21f, faces the developer supplying hole 16c of the developer holding frame 16 through the hole 33b of the backing plate 33.

After the connection between the developer holding frame 16 and developing means holding frame 17, the flexible seal 21 is in the form of a pouch, with one of the mutually facing two halves of the flexible seal 21, or one side of the pouch, having the first hole 21f, and the other half, or the other side of the pouch, having the second hole 21e. The first hole 21f of the one side of the pouch faces the developer supplying hole 16c of the developer holding frame 16 through the hole 33b of the backing plate 33, whereas the second hole 21e of the other side of the pouch faces the developer receiving hole 17b of the developing means holding frame 17. The developer supplying hole 16c is a hole through which the toner stored in the developer storing portion 16h of the developer holding frame 16 is conveyed toward the

development roller 18 as a developing member. The developer receiving hole 17b is a hole through which toner is received into the developing means holding frame 17 after passing through the developer supplying hole 16c. The flexible seal 21 is pasted to the backing plate 33 provided as a part of the developer holding frame 16, by the surrounding edge of the first hole 21f of the above described one side of the pouch, and also is pasted to the developing means holding frame 17 by the surrounding edge of the second hole 21e of the other side of the pouch.

After the flexible seal 21 is pasted to the developing means holding frame 17 and developer holding frame 16, it has at least one fold, being shaped like a bellows, one end of which is pasted to the backing plate 33 provided as a part of the developer holding frame 16, and the other end of which is pasted to the developing means holding frame 17.

The flexible seal 21 is formed of elastic material or a heat seal member.

In comparison, the flexible sheet 21i, or a different type of a flexible seal, is formed of foamed urethane, rubber with a relatively low degree of hardness, silicone, or the like.

(Developing Apparatus Structure)

It has been already described that a pair of tension springs 36 are placed in the stretched state

between the developing means holding frame 17 and cleaning means holding frame 13 (Figure 8). The following is a further development of this structure.

Next, referring to Figures 18 and 19, the structure of the developing apparatus will be described. Figure 18 is a perspective view of the components of the developing apparatus prior to their assembly, and Figure 19 is a perspective view of the components of the developing apparatus after their assembly. The developing means holding frame 17 contains structural components such as the development roller 18, development blade 26, and the like, which are involved in image formation. At this time, the description of the developing apparatus is given with reference to only one side, or the front end cover 20 side, of the apparatus. However, the structure of the developing apparatus on the other side, or the rear end cover 10 side, is the same as that on the front end cover 20 side.

The development blade 26 comprises a 1 - 2 mm thick metallic plate 26a, and a urethane rubber 26b fixed to the metallic plate 26a by hot melting, double-side adhesive tape, or the like. The amount of the toner on the peripheral surface of the development roller 18 is regulated by positioning the development blade 26 in such a manner that the urethane rubber 26b contacts the generatrix of the development roller 18.

In some cases, silicon-rubber is used for the development blade 26. Referring to Figure 18, the flat surface 17h, as a blade mounting portion, of the developing means holding frame 17 is provided with a hole 17i with female threads. It is also provided with a positioning joggle (unshown) which is located closer to the center of the developing means holding frame 17. The development blade 26 is placed on the developing means holding frame 17 so that the positioning joggle (unshown) of the developing means holding frame 17 fits through the hole 26d of the metallic plate 26a. Then, a small screw 68 is put through the screw hole 26c of the metallic plate 26a and is screwed into the hole 17i with female threads, to solidly fix the metallic plate 26a to the flat surface 17h. As a result, the position of the edge of the urethane rubber 26b is fixed, and therefore, the amount of the pressure applied to the development roller 18 by the urethane rubber 26b becomes fixed. In other words, the distance from the edge of the urethane rubber 26b to the contact point between the peripheral surface of the development roller 18 and the imaginary extension of the urethane rubber 26b toward the development roller 18 is set, determining thereby development conditions. In order to increase the rigidity of the metallic plate 26a of the development blade 26 so that the urethane rubber 26b

evenly contacts the development roller 18 in terms of the longitudinal direction of the development roller 18, the metallic plate 26a is bent approximately 900 at a line parallel to the longitudinal direction, creating a bent portion 26e. Further, the metallic plate 26a is rendered long enough to protrude from both ends of the developing means holding frame 17 after its mounting into the developing means holding frame 17, and each of these protruding end portions of the metallic plate 26a is provided with a hole 26f for anchoring a pressure generating spring which will be described later.

The developing means holding frame 17 is provided with an elastic sealing member 61, which is pasted to the developing means holding frame 17 to prevent toner from leaking out. The elastic sealing member 61 is shaped like a letter U stretched in the direction of the horizontal stroke, extending along the top edge of the developer receiving hole 17b from one end to the other (first straight portion 17n), and also extending a predetermined distance downward (second straight portion 17p) from the top of the shorter edge of the developer receiving hole 17b. It is formed of MOLTPRENE, or the like. The first and second straight portions 61c and 61a of the elastic sealing member 61 are pasted to the aforementioned first and second straight portions 17n and 17p of the

developing means holding frame 17. This elastic sealing member 61 is sandwiched between the developing means holding frame 17 and development blade 26, remaining thereby in the compressed state, to prevent toner from leaking out. The elastic sealing member 61 is also provided with an earlobe-like portion 61b, which protrudes several millimeters from the longitudinal end in the longitudinal direction, and plays a role in accurately positioning an unshown magnetic seal.

Each of the longitudinal ends of the developing means holding frame 17 is provided with a groove 17k, which is in the semicylindrical surface 171 of the developing means holding frame 17, the curvature of which matches that of the peripheral surface of the development roller 18. The groove 17k extends from the top to bottom ends of the semicylindrical surface 171, along the edge of the developer receiving hole 17b perpendicular to the longitudinal direction. In the groove 17b, a magnetic seal (unshown) is attached to prevent toner from leaking following the peripheral surface of the development roller 18, by the magnetic force of the magnetic seal.

The mandible-like portion of the developing means holding frame 17 is provided with a thin elastic sealing member (unshown), which is pasted to the

mandible-like portion in a manner to contact the generatrix of the development roller 18.

The development roller 18 is a cylindrical member formed of metallic material such as aluminum or stainless steel. It is approximately 16 - 20 mm in external diameter, and 0.5 - 1.0 mm in wall thickness. In order to improve the efficiency with which developer is charged, the peripheral surface of the development roller 18 is coated with carbon, or blasted. In this embodiment, the peripheral surface of the development roller 18 has been simply coated with carbon.

The longitudinal ends of the development roller 18 are fitted with a sleeve flange 18a (one at one of the longitudinal ends is shown), which is a cylindrical member with a step portion, formed of metallic material such as aluminum or stainless steel, and is pressed into the end of the development roller 18. The sleeve flange 18a is coaxial with the development roller 18, and has two cylindrical portions: first cylindrical portion 18d with a larger diameter and second cylindrical portion 18c with a diameter smaller than that of the first cylindrical portion. The first cylindrical portion 18d is fitted with a distance regulating member 18b in the form of a ring (which may be referred to as spacer ring) for regulating the distance (which hereinafter will be

referred to as "SD gap") between the peripheral surfaces of the development roller 18 and photosensitive drum 11. The spacer ring 18b is formed of dielectric material such as polyacetal. The external diameter of the spacer ring 18b is greater by twice the SC gap than the external diameter of the development roller 18. The second cylindrical portion 18c is fitted in a development roller bearing 63 (shown in Figure 20, which is an enlarged perspective view of the end cover 20 side of the developing apparatus, on the side opposite to the side shown in Figure 18 or 19) for accurately positioning the development roller 18 relative to the developing means holding frame 17 while rotationally supporting the development roller 18. The end portion of the second cylindrical portion 18c has been flatted to give it the so-called double "D" cross section. A development roller gear 62 formed of synthetic resin is fitted around the cylindrical portion 18c, being prevented by this flatted portion 18e from rotating around the cylindrical portion 18c. The development roller gear 62 is driven by a helical drum gear (unshown) attached to one of the longitudinal ends of the photosensitive drum 11, and rotates the development roller 18. The teeth of the development roller gear 62 are twisted in the direction to thrust the development roller 18 toward the center of the developing apparatus. Within

the development roller 18, a cylindrical magnet (which is not shown in Figure 18, and will be described later) for adhering toner onto the peripheral surface of the development roller 18 is placed.

The development roller bearing 63 is a virtually flat member with an approximate thickness of 2 - 5 mm, and is formed of resinous material with a higher level of slipperiness. It has the cylindrical bearing portion 63a, which is located in the approximate center of the flat portion 63g. The internal diameter of the bearing portion 63a is in a range of 8 - 15 mm. In this bearing portion 63a, the second cylindrical portion 18c of the sleeve flange 18a is fitted to allow the development roller 18 to rotate, with the peripheral surface of the second cylindrical portion 18c sliding on the wall of the hole of the bearing portion 63a. The flat portion 63g is provided with a joggle 63c, which projects approximately in parallel to the axial line of the bearing portion 63a to accurately position the development roller bearing 63 relative to the developing means holding frame 17. The joggle 63c is divided into three portions: base portion, portion 63d, or the middle portion, and portion 63e, or the end portion, which are coaxial. The portions 63d and 63e of the joggle 63c are used to accurately position the magnetic seal. Further, the flat portion 63g is

provided with screw holes 63b for solidly fixing the development roller bearing 63 to the developing means holding frame 17, with the use of small screws 64 or the like. More specifically, the joggle 63c of the development roller bearing 63 fits into an unshown hole provided in the end wall of the developing means holding frame 17 in terms of the longitudinal direction, and the joggle 63f of the development roller bearing 63 fits into another unshown hole, with the elongated cross section, of the same end wall of the developing means holding frame 17, so that the flat portion 63g of the development roller bearing 63 flatly contacts the above described end wall of the developing means holding frame 17. Then, the small screws 64 are put through the corresponding screw holes of the development roller bearing 63, and screwed into the corresponding unshown female threaded holes of the developing means holding frame 17. With this structural arrangement, the development blade 26 and development roller 18 are accurately positioned relative to the developing means holding frame 17, assuring that high quality images are consistently outputted.

In some cases, a highly slippery substance (for example, polyphenylene sulfide, or polyamide), which is relatively costly, is used as the material for the bearing portion 63a of the development roller

bearing 63 in order to allow the sleeve flange 18a to smoothly rotate. In such cases, the cost of the development roller bearing 63 can be reduced by dividing the development roller bearing 63 into a bushing portion which actually bears the development roller 18, and a housing portion, because only the bushing portion, or the portion with a smaller volume, requires highly slippery material, whereas the housing portion, or the substantial portion of the development roller bearing 63, may be formed of relatively inexpensive material such as high impact polystyrene or the like.

Within the development roller 18, a magnet (unshown) for adhering toner onto the peripheral surface of the development roller 18 is placed.

In the above, the developing apparatus is described with reference to the side from which the development roller 18 is driven (driven side). The side of the developing apparatus from which the development roller 18 is not driven (non-driven side) will be described later.

(Structure for Supporting Developing Apparatus)

Next, referring to Figures 7, 20, 21, 22, and 23, the structure for supporting the developing apparatus will be described. Figure 20 is a perspective view of the developing apparatus, on the driven side, before the developing apparatus is

supported by the cleaning means holding frame 13. Figure 21 is a perspective view of the developing apparatus, on the driven side, after the developing apparatus is supported by the cleaning means holding frame 13. Figure 22 is a partially enlarged side view of the driving apparatus, on the driven side, with the end cover removed. Figure 23 is a perspective view of the developing means holding frame and end cover, on the non-driven side, before the end cover is attached to the developing means holding frame.

As described before, in order to output an image of optimum quality, an optimum SD gap (gap between photosensitive drum 11 and development roller 18) must be kept between the development roller 18 and photosensitive drum 11. For this purpose, in this embodiment, the development roller 18 is pressed upon the photosensitive drum 11 with the application of an optimum amount of pressure (which hereinafter will be referred to as D pressure) to maintain the SD gap (Figure 2). In this embodiment, this optimum amount of the D pressure is approximately 500 g - 2,000 g on both the driven and non-driven sides. If the D pressure (contact pressure between spacer ring and photosensitive drum 11) is no more than the amount within this range, the SD gap tends to widen due to vibrations or the like, and image defects such as unwanted white spots or the like occur. If the D

pressure is no less than the amount within this range, the spacer ring 18b is collapsed by the D pressure, allowing the SD gap to narrow. Further, it is possible that, with the elapse of time, the spacer ring 18b is shaved due to the load exerted upon the peripheral surface and internal surfaces of the spacer rings 18b, or the like damages occur to the spacer rings 18b, failing to maintain the optimum amount of SD gap. In this embodiment, the following structural arrangement is employed to maintain the optimum amount of SD gap. Hereafter, the supporting of the developing apparatus (method for maintaining SD gap) will be separately described for the driven side and non-driven side.

Referring to Figures 20, 21, and 22, on the driven side, the developing means holding frame 17 (developing apparatus inclusive of development roller, development blade, and the like) and cleaning means holding frame 13 are positioned relative to each other so that the suspension hole 17d located in the end portion of the arm portion 17c of the developing means holding frame 17 aligns with the support hole 13e of the cleaning means holding frame 13, and a parallel pin 66 is inserted through the suspension hole 17d and support hole 13e. As a result, the developing means holding frame 17 and cleaning means holding frame 13 16 are connected, being enabled to pivot relative to

each other about the parallel pin 66 in such a manner that the axial line of the development roller 18 moves toward the axial line of the photosensitive drum 11. Referring to Figure 22, with this structural arrangement, the amount of the pressure by which the development roller 18 is pressed upon the photosensitive drum 11, on the driven side, is the combination of three forces: a working pressure F1 (load exerted at the pitch point between the gear portions 11a1 and 62b in the direction of transverse line of action upon tooth) between the gear portion 11a1 of the flange 121a of the photosensitive drum 11 and the gear portion 62b of a development roller gear 62; a force F2 generated by the resiliency of the tension spring 36 stretched between the cleaning means holding frame 13 and developing apparatus; and a force F3 which applies to the center of gravity of the developing apparatus due to the self-weight of the developing apparatus. In other words, the structural arrangement is such that all three forces work in the direction to pivot the developing apparatus about the parallel pin GG (pivotal center) in the counterclockwise direction so that the development roller 18 is pressed upon the photosensitive drum 11. Further, the structural arrangement is made so that the angle which the line connecting the contact point between the photosensitive drum 11 and spacer ring

18b, and the pivotal center (66) forms relative to the transverse line of action of the force F1, becomes small, for example, approximately 5 deg. This is due to the following reason. That is, the working pressure F1 fluctuates due to the fluctuation of torque, and the fluctuation of the working pressure F1 results in the fluctuation of the D pressure. Therefore, the above described structural arrangement is made to prevent the fluctuation of the D pressure. Further, the force F3 resulting from the self-weight of the developing apparatus is stable because the structural arrangement is such that the load from developer is not exerted upon the developing apparatus D as described before. Further, the tension spring 36 is positioned and supported, as will be described later, so that the resiliency of the spring 36 is not wasted. Therefore, the force F2 is stable. Thus, the D pressure D1 on the driven side remains constant in numerical value.

Referring to Figure 20, the tension spring 36 is approximately 0.5 - 1.0 mm in wire diameter. It has hook portions 36a and 36b at its ends, which are used for anchoring it. As for the material for the tension spring 36, springy material such as SUS, piano wire, phosphor bronze, or the like, is used. One of the hooks, for example, hook 36a, is anchored through the hole 26g formed in the metallic plate 26a of the

development blade 26, and the other hook, or the hook 36b, is hung around a shaft-like spring mount 13d of the cleaning means holding frame 13. The hole 26g of the development blade 26 is in the portion of the metallic plate 26a, which is projecting outward from the developing means holding frame 17. It is 2 - 5 mm in width and 4 - 8 mm in length. The spring mount 13d of the cleaning means holding frame 13 is located in the adjacencies of the photosensitive drum 11, and is 2 - 5 mm in diameter. It is an integral part of the cleaning means holding frame 13. The hole 26g and spring mount 13d are positioned so that the line connecting the hole 26g of the development blade metallic plate 26a and the spring mount 13d of the cleaning means holding frame 13, becomes approximately perpendicular to the line connecting the hole 26g and pivotal center (66). The tension spring 36 is hooked to the development blade 26, eliminating the need for providing the developing means holding frame 17 with a spring mounting portion in the form of a shaft, for example, which projects outward from the developing means holding frame 17. Therefore, the developing means holding frame 17 can be simple in the configuration of its end surfaces in terms of the longitudinal direction, which in turn makes it easier to set up a jig for attaching the flexible seal 21 to the developing means holding frame 17, improving

assembly efficiency. Further, anchoring the tension spring 36 to the development blade 26 means anchoring the tension spring 36 to a metallic component, which is high in elastic modulus, eliminating the problem that the D pressure is reduced due to the deformation or the like of the spring anchoring portion by the resiliency of the tension spring 36. Incidentally, when providing the spring anchoring portion, for example, a joggle, as an integral part of the developing means holding frame 17, such a spring anchoring portion must be rendered large enough to prevent the D pressure from being reduced by its deformation. However, in this embodiment, the developing means holding frame 17 does not need to be provided with such a spring anchoring portion, or a joggle, and therefore, contributing to size reduction.

Next, referring to Figure 23, on the non-driven side of the developing means holding frame 17, the developing means holding frame 17 is provided with an connecting member 17e, which projects outward from the developing means holding frame 17, and the axial line of which will align with that of the development roller 18. The developing means holding frame 17 is structured so that this connecting member 17e is pressed toward the center of the photosensitive drum 11. The connecting member 17e has a bearing, as an integral part of the connecting member, for supporting

the non-driven end of the development roller 18.

Next, the structure for maintaining the D pressure on the non-driven side will be described. Referring to Figures 7 and 23, to the non-driven end of the developing means holding frame 17, a connecting member 17e is fixed, the axial line of which will be in alignment with the axial line of the development roller 18. The developing means holding frame 17 is structured so that this connecting member 17e is pressed toward the photosensitive drum 11. The connecting member 17e is screwed to the developing means holding frame 17. Referring to Figure 23, it is inserted into the groove 19e (which in this embodiment is an elongated hole, the long axis of which is approximately parallel to the line connecting the axial lines of the development roller 18 and photosensitive drum 11) of the rear end cover 19, being enabled to move in the direction of the line connecting the axial lines of the development roller 18 and photosensitive drum 11. In the groove 19e, an elastic member 67 is placed on the side opposite to the photosensitive drum 11, with the connecting member 17e fitted in the groove 19e on the photosensitive drum 11 side, in a manner to sandwich the connecting member 17e and press the connecting member 17e by the pressing portion 67a. The elastic member 67 is a compression coil spring, the wire diameter of which is

approximately 0.5 - 1.0 mm. The resiliency of this spring generates a pressure D2 which presses the non-driven end of the development roller 18 upon the photosensitive drum 11. In other words, the amount of the pressure D2 is determined by the resiliency of the coil spring alone, and therefore, is stable. This groove 19e also functions to as a positioning groove, playing a role in regulating the direction in which the development roller 18 moves. As seen from the inward side of the rear end cover 19, the groove 19e is narrower on the outward side, preventing the pressing portion 67a from dislodging outward from the groove 19e.

The flat surface 67b of the pressing portion 67a is in contact with the elastic member 67. The flat surface 67b is perpendicular to the direction in which the elastic member 67 exerts pressure. The surface of the pressing portion 67a, which is on the opposite side of the portion of the pressing portion 67a, on which the flat surface 67b is, is a flat surface, and is in contact with the flat portion 17e1 of the connecting member 17e. The flat portion 17e1 is the location upon which the pressure from the elastic member 67 is exerted.

(Description of Coupling Member)

Next, referring to Figures 24 - 26, the configurations of the coupling members will be

described.

Referring to Figure 24, a first coupling 105a, that is, a member through which the force for driving the process cartridge 15 is received, has a projection 105a1 which is approximately triangular in cross section. More specifically, the projection 105a1 is in the form of a triangular pillar twisted about its axial line in the direction in which it is rotated. A first coupling 103, that is, the coupling on the apparatus main assembly side, has a hole 103a which is approximately triangular in cross section, and is twisted about its axial line in the direction in which the first coupling 103 is rotated, With the provision of the above described structural arrangement, as the first coupling 103 on the apparatus main assembly side is rotated after the first coupling 105a on the process cartridge side and first coupling 103 on the apparatus main assembly side are engaged, the two couplings 103 and 105a rotate in such a manner that the edges of the projection 105a1 simultaneously make contact with the corresponding walls of the hole 103a. As a result, the axial lines of the first coupling 103 on the apparatus main assembly side and first coupling 105a on the process cartridge side become aligned, and therefore, the driving force is smoothly transmitted.

As described above, the first coupling 105a

and main assembly first coupling 103 are projection and hole, respectively, which are in the form of a twisted triangular pillar, and therefore, as they rotate in engagement with each other, thrust is generated in the direction to pull them toward each other in their axial directions.

Referring to Figures 25 and 26, a second coupling 104 on the main assembly side of the image forming apparatus has a portion with two parallel flat surfaces formed by flatting the cylindrical portion, and one flat surface has a pair of contact areas 104a, and the other flat surface has a pair of contact areas 104b. In other words, both ends of each flat surface, in terms of the direction perpendicular to the longitudinal direction, constitute the contact area. On the other hand, each end of the portion with the two parallel flat surfaces has two different contact areas: contact area 104a and contact area 104b. The second coupling 106a on the process cartridge side has a hole 106d, in which a pair of triangular ribs are placed on the wall of the hole in such a manner that the pair of triangular ribs become symmetrical with respect to the axial line of the hole 106d and extend in the axial direction of the hole 106d. The side surfaces of each rib are perpendicular to each other and have contact area 106e and 106f, respectively.

Referring to Figure 25, as the second

coupling 104 on the main assembly side is rotated in the direction indicated by an arrow mark E, that is, the direction in which the developer seal 24 is opened by an unshown automatic seal opening mechanism, the contact area 104a of the second coupling 104 on the main assembly side contacts the contact area 106e of the triangular rib of the second coupling 106a on the process cartridge side, and transmits driving force to the second coupling 106a on the process cartridge side.

In order to reduce the gaps g1 between the peripheral surface 104d of the second coupling 104 on the main assembly side, and the wall of the hole 106d of the second coupling 106a on the process cartridge side, the wall of the hole 106d has modified in shape to change the distance between the opposing two points on the wall, with respect to the axial line of the hole 106d, providing the wall of the hole 106d with a pair of surfaces 106g approximately parallel to the side surfaces 106f.

The peripheral surface of the second coupling 104 on the main assembly side has a cylindrical curvature, and the axial line of this curvature coincides with the rotational axis of the coupling 104 on the main assembly side. Referring to Figure 26, as the driving for opening the developer seal 24 is completed, the second coupling 104 on the main

assembly side rotates in reverse. As a result, the contact areas 104b of the second coupling 104 on the main assembly side come into contact with the contact areas 106f of the second coupling 106a on the process cartridge side, and drive the second coupling 106a on the process cartridge side, transmitting driving force to the toner stirring members 113, 114, and 123, and the like. During this period, the gap g2 is maintained between the second coupling 104 on the main assembly side and the second coupling 106a on the process cartridge side, in terms of their radius directions. In this embodiment, the size of the gap g2 is approximately 2 mm.

With the provision of the above described structural arrangement, while the developer seal 24 is opened, the photosensitive drum 11 is not driven, and the second coupling 104 on the main assembly side and the second coupling 106a on the process cartridge side are aligned with each other. Then, after the opening of the developer seal 24, in other words, during image formation, the first coupling 105a attached to the photosensitive drum 11, and the first coupling 103 on the main assembly side, remain aligned with each other. During this period, if the second coupling 106a on the process cartridge side and the second coupling 104 on the main assembly side, which transmit driving force to the toner stirring members 113, 114,

and 123, and the like, happen to become misaligned, they do not become aligned any more, that is, they remain misaligned, but continue to transmit driving force. In other words, the second coupling 106a on the process cartridge side and the second coupling 104 on the main assembly side are structured not to interfere with the alignment between the first coupling 103 on the main assembly side and the first coupling 105a on the process cartridge side.

(Description of Driving System)

Figure 27 is a system diagram of the drive train in this embodiment. The referential codes used in this diagram are used only in this diagram. For example, the development sleeve gear 107b in this diagram corresponds to the development roller gear 62 (Figures 7 and 20) in the actual structure.

Driving force sources 101 and 102, for example, motors, provided on the apparatus main assembly 27 side to drive the process cartridge 15 have couplings 103 and 104, respectively. With the process cartridge 15 mounted in the apparatus main assembly 27, the couplings 103 and 104, and power sources 101 and 102 are in connection with the couplings 105a and 106a which rotate with the input gears 105b and 106b, respectively, on the process cartridge side. The coupling 106a is supported by a bearing 20e. The coupling 105a and gear 105b are

integral parts of a gear flange 105, and are supported by the cleaning means holding frame 13, with the interposition of the bearing 22b. Since the system for driving the toner stirring members is provided with the driving force source 102 independent from the driving force source 101 for driving the photosensitive drum 11, the rotational velocity of the motor 102 can be varied with the provision of a controlling apparatus 121 to vary the velocity at which the toner stirring member driving system is driven.

The controlling apparatus 121 is enabled to turn on or off the driving force source 102, or vary the driving speed, according to such factors as the cumulative number of copies the process cartridge 15 has produced, the amount of the toner within the process cartridge 15, torque necessary to driving the stirring members of the process cartridge 15, and the like, that reflect the condition of the process cartridge 15.

With the provision of the driving force source 102 independent from the driving force source 101 for the photosensitive drum 11, even when the speeds of the photosensitive drum 11 and development roller 18 in the apparatus main assembly 27, which are enabled to print at high speed, are increased, the stirring speed can be kept unchanged by keeping the

driving speed of the driving force source 102 unchanged, in other words, by setting the driving speed of the driving force source 102 independent from the driving force source 101 for driving the photosensitive drum 11 and development roller 18. The driving force source 102 may be eliminated. In such a case, the force for driving the stirring system is drawn from the driving force source 101 with the interposition of a speed varying apparatus between the stirring system and the driving force source 101, so that an optimum speed can be set for the stirring system by varying the driving speed at which the stirring system is driven by the driving force source 101 in accordance with the operational mode of the apparatus main assembly 27.

Next, the driving system on the process cartridge side will be described.

The photosensitive drum 11 and development roller 18, which are directly involved in the development of an electrostatic latent image, are provided with gear flanges 105 and 107, which are fixed to the ends of the photosensitive drum 11 and development roller 18, respectively. The gear flanges 105 and 107 comprise gears 105b and 107b, which are integrally formed with the gear flanges 105 and 107, respectively. To the other ends of the photosensitive drum 11 and development roller 18, bearing flanges 119

and 120 are fixed. The photosensitive drum 11, gear flange 105, and bearing flange 119 together constitute a photosensitive drum unit, and the development roller 18, gear flange 107, and bearing flange together constitute a development roller unit. The gear 105b and sleeve gear 107b are meshed with each other.

As the coupling 103 is rotated by the driving force source 101 on the apparatus main assembly 27 side, the photosensitive drum 11 and development roller 18 rotate. The photosensitive drum unit is rotationally supported by the bearing members 22a and 22b. The development roller 18, which is fitted with the pair of spacer rings 18b which are larger in external diameter than the development roller 18 and are coaxial with the development roller 18, rotate while pressing the spacer rings 18b upon the peripheral surface of the photosensitive drum 11. Therefore, the photosensitive drum 11 and development roller 18 rotate while maintaining an optimum gap between their peripheral surfaces. The bearing members 22a and 22b are walls themselves of the holes provided in the walls of the cleaning means holding frame 13 of the process cartridge 15, or members (Figure 7) fixed to the cleaning means holding frame 13. In the bearing members 22a and 22b, the journal portions of the flanges 105 and 119 fit, respectively.

In the drive trains for the stirring system,

the driving force is transmitted to an idler gear 108 meshed with an idler gear 126, which is meshed with an input gear 106b, and then, is transmitted to an idler gear 129 fixed to a shaft 108a to which the idler gear 108 is fixed. Then, it is transmitted to an idler gear 128 meshed with an idler gear 129. The idler gear 128 is a step gear, the small diameter portion 128a of which is meshed with the stirring gears 109 and 127 to transmit the driving force to the stirring members 113 and 114. The axial line of the input gear 106b does not need to be in alignment with the axial line of the stirring member 114, and therefore, the range in which the input gear 106b must be positioned is relatively wide. The aforementioned gears in the process cartridge 15 are all rotationally supported by the frame of the process cartridge 15.

The shaft 108a of the idler gear 108 is integral with a driving force transmitting rod 122, or connected thereto in alignment therewith. The driving force transmitting rod 122 is connected to an idler gear 124, on the opposite side of the process cartridge 15 in terms of the longitudinal direction, and transmits the driving force to the stirring member 123 through a stirring gear 125 meshed with an idler gear 110a. The driving force transmitting rod 122, and stirring members 113, 114, and 123, are rotationally supported by the developer holding frame

16.

Thus, as the input gear 106b rotates, the stirring members 114, 113, and 123, and the driving force transmitting rod 122, also rotate because the journal portions of those components are rotationally supported by the bearings with which the developer holding frame 16 is provided.

Referring to Figure 24, the projection 105a1, in the form of a twisted triangular pillar, of the coupling 103 of the drum flange 105 engages into the hole 103a, in the form of a twisted triangular pillar, on the apparatus main assembly 27 side, and as the coupling 103 is driven, thrust is generated in the direction to pull the projection 105a1 into the hole 103a, and the couplings 103 and 105a are aligned with each other. Thus, as the coupling 103 is driven, the position of the process cartridge 15 relative to the apparatus main assembly 27 in terms of the longitudinal direction is determined. The projection of the coupling 104 and the hole of the coupling 106a are constructed to provide a certain amount of gap between the projection and the wall of the hole in terms of their radius directions, to afford a certain amount of misalignment between the coupling 104 and coupling 106a. Therefore, the engagement between the coupling 104 and coupling 106a does not affect the positioning of the first coupling 105a on the drum

flange side (Figures 25 and 26). In order to control the rotation of the process cartridge 15, the second guide portion 20g of the front end cover 20 is provided with a projection (which will be described later), the position of which is fixed by the apparatus main assembly 27. In other words, the couplings on the side where the driving force is transmitted to the photosensitive drum 11 for latent image formation, and the development roller 18 for latent image development, which directly affect image formation, are precisely structured so that the process cartridge 15, more specifically, the photosensitive drum 11 and development roller 18, is accurately positioned relative to the apparatus main assembly 27 by the aligning functions of the couplings. However, the couplings on the side where the driving force is transmitted to the stirring system, are roughly structured so that they engage for the sole purpose of transmitting the driving force.

Within the cleaning means holding frame 13, which doubles as the removed toner bin 5, the feather-like removed toner moving member 115 for conveying the toner removed from the photosensitive drum 11 is placed. The removed toner moving member 115 is rotationally supported by the cleaning means holding frame 13; the shaft of the removed toner moving member 115 is supported by the bearings with which the

cleaning means holding frame 13 is provided. To one end of the removed toner moving member 115, a power input gear 112 is fixed, which is connected to the gear 124 through idler gears 111c, 111b, 111a, 125, and 110a. To the end of the driving power transmitting rod 122, on the side opposite to the end to which the gear 108, or an power input gear, is fixed, in other words, on the non-driven side, the gear 124, or a power output gear, is fixed. The idler gears 111a, 111b, and 111c are rotationally supported by the rear end cover 19; their shafts are supported by the bearings with which the rear end cover 19 is provided. As the driving force transmitting rod 122 rotates, the removed toner moving member 115 is rotated by the rotation of the driving force transmitting rod 122. The shafts which support idler gears 111a, 111b, and 111c, one for one, are non-rotational shafts and are integrally formed parts of the rear end cover 19.

The idler gear 111c may be replaced with a step gear so that the large diameter portion of the step gear is meshed with the idler gear 111b, and the small diameter portion of the step gear is meshed with the removed toner moving member 112.

As described above, the process cartridge 15 essentially comprises two drive trains: the drive train for driving the photosensitive drum 11 and

development roller 18, and the drive train for driving the stirring member, and removed toner moving member. The two drive trains are independently driven by the driving force sources on the apparatus main assembly 27 side.

The drive trains may be structured so that the removed toner moving member 115 is driven by the driving force transmitted from the opposite side of the toner container 16, that is, the side opposite to the side from which the driving force is transmitted to the stirring members 113 or 114, or by the driving force transmitted from any of the power input gears 106, 109, and 127, and idler gears 108 and 128, with the interposition of a dedicated gear train.

(Structure of Cooling Air passage)

Figures 28 and 29 are drawings of a typical gear train positioned in the adjacencies of the photosensitive drum 11. Figure 28 is a side view of the process cartridge 15 with the side cover removed, whereas Figure 29 is a side view of the process cartridge 15 with the contour of the side cover indicated by a double-dot chain line. Within the cleaning means holding frame 13, the removed toner moving member 115 for conveying the recovered removed toner, inward of the removed toner bin 5, is placed. In order for the removed toner moving member 115 to be driven by the photosensitive drum 11, the driving

speed must be drastically reduced sometimes. However, when a structural arrangement is made so that the removed toner moving member 115 is driven by the toner stirring member 114 within the developer holding frame 16, the drastic speed reduction is unnecessary, making it easier to provide the removed toner moving member 115 with a proper driving speed. In such a case, the gears 111b and 111c are positioned in the adjacencies of the photosensitive drum 11 and outside the developer holding frame 16 and developing means holding frame 17 (Figure 28).

In this embodiment, in order to prevent temperature increase in the adjacencies of the photosensitive drum 11, the rear end cover 19 is provided with an air passage 19f (Figure 19), which is located in the adjacencies of the photosensitive drum 11. However, the air passage 19f for cooling the interior of the process cartridge 15 is blocked by the gears 111b and 111c of the gear train. Thus, the gears 111b and 111c are provided with slits 34a and 34b, which are cut in a manner to constitute an axial flow fan to forcefully take in or exhaust air through the air passage 19f.

Next, referring to Figures 30, 31, and 32, the structure of the cooling air passage will be described. Figure 31 is a perspective view of the gear 111c. The gear 111b is the same as the gear 111c

except that they are different in both the direction in which the teeth are twisted and the direction in which the air passage is twisted. Therefore, the structure of the cooling air passage will be described with reference to only the gear 111c. Figure 32 is a development of the gear 111c at a plane B-B in Figure 31, and Figure 30 is a sectional view of the gear 111c at a plane A-A in Figure 31.

The gear 111c is a helical gear comprising a rim 111c2, a boss 111c1, and a disk-shaped hub 111c3. The hub 111c3 has a plurality of slits 34a, which radially extend, being evenly distributed in terms of the circumferential direction. There is a gap between the surface of the hub 111c3 and the inward surface 19i of the rear end cover 19. Thus, the air passage 19f of the rear end cover 19, which connects the inward and outward sides of the rear end cover 19, is connected to the slits 34a through a space 46. The gear 111c is rotationally supported by the shaft 19G, which projects inward from the inward surface of the rear end cover 19 in the longitudinal direction and is put through the central hole of the boss 111c1. The shaft 19G is fitted with an unshown stopper ring to prevent the gear 111c from shifting in the axial direction of the shaft 19G. The lateral surface 111c4 of the rim 111c2 is positioned as close as possible to the inward surface 19i of the rear end cover 19 to

make as small as possible the amount of the air which passes between the surfaces 19i and 111c4. Incidentally, in order to make as small as possible the amount of the air which passes between the surfaces 19i and 111c4, these surfaces may be intricately configured in a manner to form a labyrinth.

The slits 34a are positioned so that they align with the air passage 19f in terms of the radius direction of the gear 111c.

Referring to Figure 32, the portion of the hub 111c3, between the adjacent two slits 34a, constitutes a helical fan blade 34g. In order to improve the air blowing efficiency of the gear 111c, each slit 34a is desired to be aerodynamically shaped to give the helical fan blade 34g the aerodynamic shape of the fan blade of an axial flow fan. However, since the rotational velocity of the gear 111c is rather slow, the blade 34g may be simply tilted. As the slits 34a are cut in the hub 111c3 as described above, an impeller is formed inside the rim 111c2 in terms of the radial direction of the rim 111c2.

Referring to Figures 31 and 32, as the gear 11c rotates in the direction indicated by an arrow mark 34c, air flows in the axial direction and enters the space 34 as indicated by an arrow mark 34d in Figure 30. Then, the air flows from the space 46

toward the air passage 19f, and is exhausted from the process cartridge 15 through the air passage 19f of the rear end cover 19.

Since the space 46 is located so that it faces all the slits 34a at the same time regardless of their rotational positions, all fan blades 34g contribute to the generation of air flow.

If the direction in which the surface 34f of each fan blade 34g is tilted is reversed, the direction of the air flow is reversed to send the ambient air of the image forming apparatus into the process cartridge 15, even if the rotational direction of the gear 111c is kept the same. The fan blade 34g is tilted in the direction most effective for cooling, in consideration of the component positioning, and the overall structure of the air passage.

Matching the direction in which each tooth 34e of the helical gear 111c is twisted to the direction in which the surface 34f of each fan blade 34g is twisted makes the same the directions in which air flow is generated in the axial direction of the gear 111c by the helical teeth portion and axial fan portion of the gear 111c, and is advantageous when constructing a mold for forming the gear 111c using resin. When making a structural arrangement so that the teeth 34e and fan blades 34g of the gear 111c send air in the same direction in terms of the axial

direction of the gear 111c, a gap should be provided between the lateral surface of the rim 111c2 and the inward surface of the rear end cover 19 to allow air to flow through, and a cover which follows the peripheral surfaces of the gear 111c, except for the area across which the gear 111c meshes with its counterpart, should be provided as if providing an air blower with casing.

Since an impeller is provided as a part of the gear 111c by cutting the plurality of slits 34a in a manner to form the plurality of fan blades 34g with the tilted surface 34f as described above, and the gears 111b and 111c rotate when forming images, the internal air of the process cartridge 15, in particular, the air in the adjacencies of the charging portion and cleaning blade, which increases in temperature, is exhausted without becoming stagnant, and also the heat generated by the fixing apparatus or the like is removed. Incidentally, the image forming apparatus main assembly 27 is provided with ventilating means (unshown), for example, air vents through which the internal air of the apparatus main assembly 27 is replaced with the ambient air, naturally, or forcefully with the use of a fan.

(Structure of Developing Means Holding Frame)

Next, referring to Figures 7, 9, and 34 - 38, the structure of the developing means holding frame 17

will be described. Figure 9 is a side view of the process cartridge 15 on the front end cover 20 side, with the front end cover 20 removed. Figure 34 is a side view of the process cartridge 15 on the rear end cover 19 side, with the rear end cover 19 removed except for a certain portion. Figure 36 is an exploded perspective drawing for showing how the end of the developing means holding frame 17, on the rear end cover side, is positioned relative to the rear end cover 19.

The development roller unit comprising the development roller 18 and cylindrical magnet 23 placed within the development roller 18 is rotationally supported by the developing means holding frame 17, with the interposition of the pair of connecting members 17e which double as development roller bearings. The connecting members 17e are secured to the developing means holding frame 17 with the use of the small screws 41 (Figure 2), being accurately positioned relative to the developing means holding frame 17. In addition, the development blade 26 (Figure 26) and the unshown magnetic seal are attached to the developing means holding frame 17.

One end of the magnet 23 is rotationally supported by the internal surface of the development roller 18, and the other end is non-rotationally supported by the connecting member 17e which doubles

as a development roller bearing, holding a predetermined gap between itself and the development roller 18. Electric power is transmitted to the development roller 18 through an unshown electrical contact provided within the development roller 18. Around the development roller 18, the pair of spacer rings 18b are fitted (Figure 37) to keep constant the gap between the peripheral surfaces of the development roller 18 and photosensitive drum 11.

(Structure for Supporting Development Roller and Magnet)

Next, referring to Figures 35 - 37, the structure for supporting the development roller 18 and magnet 23 will be described. Figure 35 is an external perspective view of the connecting member 17e which doubles as a development roller bearing, and Figure 36 is an exploded perspective view of the connecting member 17e of the process cartridge 15, and its adjacencies. Figure 37 is a partial vertical sectional view of the process cartridge 15.

The development roller 18 is a cylindrical member formed of metallic material such as aluminum or stainless steel. It is approximately 16 - 20 mm in external diameter, and 0.5 - 1.0 mm in wall thickness. In order to improve toner charging performance, the peripheral surface of the development roller 18 is coated with carbon, or is blasted (in this embodiment,

it is simply coated with carbon). The non-driven end of the development roller 18 is provided with a hole 18f into which a sleeve flange 18j is pressed to be secured to the development roller 18.

Referring to Figure 36, the sleeve flange 18j is a hollow cylindrical member formed of metallic material such as aluminum or stainless steel. It is a stepped flange, and is secured to one end of the development roller 18 by being pressed into the hole at the end of the development roller 18. It has a portion 18j1 which is pressed into the end of the development roller 18; it is secured to the development roller 18 by pressing this portion 18j1 into the development roller 18. The sleeve flange 18j also has a flange 18j3 and a small diameter portion 18j2, which are on the outward side of the portion 18j1 in terms of the axial direction of the development roller 18. The flange 18j3 is approximately the same in diameter as the development roller 18. The small diameter portion 18j2 is smaller in external diameter than the portion 18j1, and its axial line coincides with that of the portion 18j1. The spacer ring 18b for regulating the distance between the development roller 18 and photosensitive drum 11 is fitted around this small diameter portion 18j2 of the sleeve flange 18j. Further, the sleeve flange 18j is provided with a journal portion 18j4,

which is on the outward side of the small diameter portion 18j2 and is smaller in diameter than the small diameter portion 18j2.

Further, the sleeve flange 18j is provided with a through hole 18j5, which is coaxial with the journal portion 18j4. The end portion of the magnet 23 is put through this through hole 18j5 to precisely position the magnet 23 relative to the developing means holding frame 17, with the interposition of the connecting member 17e.

Referring to Figure 36, the magnet 23 comprises a large diameter portion 23a, or the center portion, and support portions 23b and 23c, or the end portions. The large diameter portion 23a is contained within the development roller 18. The large diameter portion 23a has been magnetized so that a plurality of magnetic poles are exposed at the peripheral surface of the large diameter portion 23a. Generally, one of the plurality of magnetic poles is made to approximately oppose the photosensitive drum 11, and the other magnetic poles are made to face optimal directions. The total number of the magnetic poles is four. In order to keep the magnetic force constant at the peripheral surface of the development roller 18, the distance between the peripheral surface of the large diameter portion 23a of the magnet 23 and the peripheral surface of the development roller 18 must

be kept constant, and in order to keep this distance constant, the support portion 23c of the magnet 23 is supported by the connecting member 17e. Further, in order to keep the magnetic poles accurately positioned in terms of the circumferential direction, the support portion 23c of the magnet 23 is provided with a D-cut portion 23c1, which regulates the positioning of the magnet 23 in terms of its circumferential direction. The other support portion 23b of the magnet 23 is supported by the magnetic roller bearing (unshown) in the other sleeve flange 18a (Figures 7 and 18).

The connecting member 17e is formed of resin, and has an approximately 2 - 5 mm thick flange portion 17e4 and a projection 17e2 having an external diameter of approximately 8 - 15 mm. The projection 17e2 fits in the groove 19e of the rear end cover 19. The peripheral surface of the projection 17e2 has a flat portion 17e1, which will be approximately perpendicular to the line connecting the axial lines of the development roller 18 and photosensitive drum 11 after the assembly of the process cartridge 15. This flat portion 17e1 is the surface which catches the pressure generated by the elastic member 67, that is, the aforementioned compression spring, through the aforementioned pressing member 67a, and assures that the development roller 18 is kept pressed toward the photosensitive drum 11. This structural arrangement

assures that the development roller 18 is kept pressed toward the photosensitive drum 11 without wasting the pressure generated by the resiliency of the compression spring, and the distance between the peripheral surfaces of the development roller 18 and photosensitive drum 11 is kept constant under any condition to constantly produce images of good quality.

The flange portion 17e4 of the connecting member 17e has a cylindrical first hole 17e3, as a bearing portion, which is in the surface on the side opposite to the surface with the projection 17e2. The axial line of this hole 17e3 coincides with the axial line of the peripheral surface of the projection 17e2, and the diameter of the hole 17e3 is approximately 8 - 15 mm. The journal portion 18j4 of the sleeve flange 18j is rotationally fitted in this hole 17e3 to allow the development roller 18 to smoothly rotate. The position of the development roller 18 relative to the photosensitive drum 11 in terms of the rotational direction is precisely fixed by the combination of the connecting member 17e and rear end cover 19 alone; in other words, it is determined by the combination of the connecting member 17e and rear end cover 19 alone how accurately the development roller 18 is positioned relative to the photosensitive drum 11 in terms of parallelism. More specifically, it is possible that

even when the axial lines of the photosensitive drum 11 and development roller 18 remain parallel to each other in a plane parallel to the surface of the paper on which Figure 37 is drawn, they may cross each other in a plane perpendicular to the surface of the paper on which Figure 37 is drawn, and therefore, the gap between the peripheral surfaces of the photosensitive drum 11 and development roller 18 may become nonuniform in terms of the longitudinal direction, and also changes may occur to the development position in terms of the circumferential direction. However, the above described structural arrangement eliminates such a possibility.

Further, the connecting member 17e3 is provided with a second hole 17e5 as a positioning hole, which is on the inward side of the hole 17e3 and has a D-shaped cross section. The axial line of the hole 17e5 coincides with the that of the projection 17e2. The D-cut portion 23c1 of the magnet 23 is fitted in this second hole 17e5 to accurately position the magnet 23 in terms of its circumferential direction. In other words, the positional relationship between the magnet 23 and development roller 18 is precisely determined by only a single component, or the connecting member 17e, and therefore, it is easy to assure that the magnet 23 and development roller 18 are precisely positioned

relative to each other.

As described above, the magnet 23 needs to be positioned so that one of the four magnetic poles of the magnet 23 approximately opposes the photosensitive drum 11. Since the position of the magnet 23 relative to the photosensitive drum 11 is determined by the combination of the connecting member 17e and rear end cover 19 alone, it is also easy to assure that the magnet 23 is accurately positioned relative to the photosensitive drum 11.

Referring to Figure 35, the flange portion 17e4 of the connecting member 17e is provided with a pair of screw holes 17e6, which double as positioning holes and are positioned sufficiently apart from each other. Also as shown in Figure 35, the connecting member 17e is precisely positioned relative to the developing means holding frame 17, and is solidly fixed to the developing means holding frame 17 with use of the small screws 41 (Figure 23). As a result, the positional relationship between the development blade 26, magnetic seal, and the like, which have been fixed to the developing means holding frame 17, and the magnet 23 and development roller 18, the positions of which are fixed by the connecting member 17e, is determined.

To repeat the descriptions of the components of the above described structure in the order in which

they are assembled, with reference to Figures 36 and 37, first, the cylindrical portion 18j1 of the sleeve flange 18j is pressed into the hole 18f, that is, the hole in one end of the development roller 18 to securely fix the sleeve flange 18j to the development roller 18. Next, the magnet 23 is inserted into the development roller 18, and the other sleeve flange 18a and a magnetic roller bearing (unshown) are inserted, completing the development roller unit.

Next, the pair of spacer rings 18b are fitted around the small diameter portion 18j2 of the sleeve flange 18j, and the second cylindrical portion 18c of the sleeve flange 18a, one for one, and the development roller gear 62 (Figures 7 and 18) is fitted around the flatted portion 18e of the sleeve flange 18a. Then, the combination of the above described components is attached to the developing means holding frame 17, with the interposition of the connecting members 17e. Thereafter, a unit formed by fitting the elastic member 67, or a compression spring, around the projection (unshown) of the flat surface 67b of the pressing member 67a, is fitted in the groove 19e of the rear end cover 19. Then, the projection 17e2 of the connecting member 17e having been solidly fixed to the developing means holding frame 17 is inserted into the groove 19e of the rear end cover 19. As the projection 17e2 is inserted into

the groove 19e, the pressing member 67a is pressed inward against the resiliency of the elastic member 67 (state shown in Figure 37).

As is evident from Figure 37, the positions of the development roller 18 and magnet 23 are fixed by the rear end cover 19, with the interposition of the connecting member 17e, and the surface which catches the pressure is also provided on the developing means holding frame 17 side. The phase of the D-cut portion 23c1 of the magnet 23 relative to the magnetic poles is optional. However, if the magnetic poles of the magnet 23 are positioned so that as the D-cut portion 23c1 is inserted into the second hole 17e5 of the connecting member 17e, the flat surface of the D-cut portion 23c1 becomes perpendicular to the plane connecting the axial lines of the development roller 18 and photosensitive drum 11, the second hole 17e5 and projection 17e2 of the connecting member 17e can be made coaxial, and similar in cross section, enabling component processors to improve efficiency.

Giving some components multiple functions as described above makes it possible to reduce component count, and as a result, it becomes possible to provide a user with an inexpensive process cartridge. Further, fixing the positions of the essential components such as the photosensitive drum 11,

development roller 18, and magnet 23, which are extensively involved in image formation, with the use of only a small number of components makes it possible to improve the level of preciseness at which these essential components are positioned relative to each other, so that image quality is improved and stabilized.

The connecting member 17e has the first hole 17e3 as its bearing portion, by which the development roller 18 is rotationally supported. Therefore, a substance such as PPS or PA which is superior in terms of slipperiness is sometimes used as the material for the connecting member 17e. Such a substance is relatively expensive, and therefore, usage of such a substance results in cost increase. This problem can be solved by dividing the connecting member 17e into two independent pieces: bushing 39 as an actual bearing, and a main portion 17ea with a hole 17e3a in which the bush 39 is fitted. With this arrangement, the volume of the component which requires expensive material can be small, and relatively inexpensive substance such as HIPS or the like can be used as the material for the main portion 17ea of the connecting member 17e, making it possible to reduce cost. Further, modifying the shape of the bushing makes it possible to integrate the connecting member 17e with the developing means holding frame 17 (all that is

necessary is to diagonally insert the development roller or the like during assembly). With the integration of the connecting member 17e with the developing means holding frame 17, not only can the small screws or the like be eliminated, but also component count and the number of assembly steps can be further reduced. As a result, cost can be further reduced.

The above described process cartridge 15 is approximately 4 kg in weight, approximate 460 mm in length, approximately 300 mm in width, and approximately 110 mm in height.

(Means for Mounting process Cartridge into Image Forming Apparatus Main Assembly)

Referring to Figure 43(L), the front of the apparatus main assembly 27 is provided with a double-leafed hinged door 60. As this door 60 is opened as shown in Figure 43(M), an opening 100a, through which the process cartridge 15 is inserted, is exposed as shown in Figure 40. A process cartridge mounting portion 71 can be seen through this opening 100a.

As can be seen through the opening 100a, the process cartridge mounting portion 71 is provided with a guide 72 in the form of a rail, which belongs to the main assembly side, a first guiding groove 73a, a second guiding groove 73b, and a flat guiding portion 73c (guiding grooves 73a and 73b and flat guiding

portion 73c together will be referred to as a guide 73). These guiding portions are fixed to the apparatus main assembly 27 and extend in the front to rear direction of the apparatus main assembly 27. The guide 72 is located at the top left of the opening 100a, and the guide 73 is located at the bottom right of the opening 100a. The guide 72 is a straight groove and is approximately parallel to the photosensitive drum 11. It is in the form of a semicylinder, being open on the top side, and its inward surface functions as the guiding surface. The first and second guiding grooves 73a and 73b are parallel to the guide 72 on the main assembly side.

Referring to Figure 44, the guide 72 does not reach all the way to the deepest end of the process cartridge mounting portion, creating a trap portion 72a. The guide 73 extends inward from the opening 100a, reaching a cylindrical member 53 of the wall 52 of the cartridge mounting portion. The wall 52 is the wall located at the deepest end of the cartridge mounting portion as seen from the opening 100a. The cylindrical member 53 has an approximately cylindrical hole 53a. This hole 53a is approximately parallel to the photosensitive drum 11, and aligns with the guide 73 as seen from above the apparatus main assembly 27. However, the axial line of the hole 53a of the cylindrical member 53 is located higher than the axial

line of the semicylindrical guide rail 73. The detail of this positional relationship will be given in the description of the functions of the guides.

The cartridge mounting portion 71 is provided with a vertical movement lever 78, that is, a movable member, for lifting or lowering the process cartridge 15, which is located at the top left of the deepest end of the cartridge mounting portion 71. The vertical movement lever 78 is attached to a shaft 74 which is rotationally supported by the front end plate 100b and rear end plate 52 of the apparatus main assembly 27. The shaft 74 projects frontward beyond the end plate 100b, and the base portion of an external lever 77 is solidly fixed to the portion of the shaft 74, which is projecting frontward from the end plate 100b. The shaft 74 is horizontally positioned and is perpendicular to the direction in which recording medium is conveyed. Therefore, the vertical movement lever 78 can be moved in the vertical direction by the external lever 77. The vertical movement lever 78 is provided with a cam groove 78a, which catches the engaging portion 20n (which will be described later) of the process cartridge 15.

The aforementioned first coupling 103 and second coupling 104 on the apparatus main assembly side are projecting into the cartridge mounting

portion 71, or the cartridge mounting space, from the deep end plate 52 of the cartridge mounting portion of the apparatus main assembly 27.

The space immediately below the cartridge mounting portion 71 constitutes a path through which a sheet S is conveyed. Also in the cartridge mounting space 71, a pair of stands are placed one for one corresponding to both ends of the transfer roller 9 positioned in this sheet conveyance path. Each stand has a positioning recess 75. In the positioning recess 75a (which is on the rear side in terms of the process cartridge insertion direction), the shaft 22a1 of the bearing member 22a for supporting the photosensitive drum 11 of the process cartridge 15 fits. The axial line of the shaft 22a1 coincides with that of the photosensitive drum 11. Therefore, the non-driven end of the photosensitive drum 11 is accurately positioned relative to the apparatus main assembly 27. In the positioning recess 75b, the bearing member 22b, which surround the first coupling 105a on the process cartridge side, and the axial line of which coincides with the first coupling 105a, fits. This bearing member 22b is a cylindrical member, and doubles as a positioning member. With the bearing member 22b fitted in the positioning recess 75b, the axial line of the bearing member 22b, that is, the axial line of the photosensitive drum 11,

approximately aligns with the axial line of the first coupling 103 on the apparatus main assembly side; the misalignment between the axial lines of the first coupling 103 on the apparatus main assembly side and bearing member 22b is within an approximate range of 100 microns to 1 mm. As the first coupling 103 on the apparatus main assembly side rotates, the first coupling 105a on the process cartridge side is aligned with the first coupling 103 on the apparatus main assembly side. As a result, the photosensitive drum 11 rotates with its axial line aligned with that of the first coupling 103 on the apparatus main assembly side. Thus, while the photosensitive drum 11 is rotating, the bearing member 22b which is doubling as a positioning member, does not remain unyieldingly positioned in the positioning recess 75b at the deep end of the process cartridge mounting portion, in other words, remains in the state of floating. Next, the cartridge mounting means on the process cartridge side will be described.

Referring to Figure 5, the process cartridge 15 is provided with a first guiding portion 15a, which is located at the top left corner of the deep end of the process cartridge 15 and is guided by the stationary guide 72 on the apparatus main assembly side. The first guiding portion 15a is shaped so that the long edge portion points downward. The long edge

portion has a cylindrical curvature, which approximately matches that of the photosensitive drum 11. This long edge portion of the first guiding portion 15a fits in the semicylindrical groove of the guide 72. The process cartridge 15 is provided with only one first guiding portion 15a, which is located at the front end of the process cartridge 15 in terms of the cartridge insertion direction. The first guiding portion 15a has a horizontal portion 15a-1 which is approximately parallel to the top surface of the cartridge frame, and a vertical portion 15a-2 which extends downward from the horizontal portion 15a-1. The bottom edge of the vertical portion 15a-2 is guided by the stationary guide 72 on the apparatus main assembly side.

Referring to Figure 6, the process cartridge 15 is provided with a second guiding portion 20g, which is located at the bottom right corner of the front end of the process cartridge 15 in terms of the cartridge insertion direction, that is, the farthest portion from the above described first guiding portion 15a in terms of the direction perpendicular to the cartridge insertion direction. The second guiding portion 20g has a support portion 20g2 which is an integral part of the front end cover 20, and a virtually cylindrical projection 20g2 like a cylindrical boss which projects from this support

portion 20g2 approximately in parallel to the photosensitive drum 11. The bottom portion of the projection 20g1 and the bottom portion of the support portion 20g2 have the same cylindrical curvature, forming a continuous surface. The diameter of the projection 20g1 is such that allows the projection 20g1 to loosely fit in the hole 53a of the cylindrical member 53. The second guiding portion 20g is an integral part of the front end cover 20.

Also referring to Figure 6, the process cartridge 15 is provided with a first guiding portion 15a, which is located at the top left corner of the front end of the process cartridge 15 in terms of the direction in which the process cartridge 15 is inserted into the apparatus main assembly 27. The first guiding portion 15a projects leftward from the process cartridge 15 and bends diagonally downward. The longitudinal edge of the first guiding portion 15a has a semicylindrical shape. The process cartridge 15 is provided with an engaging member 20n in the form of a round pin, which is located at the top left corner of the front end of the process cartridge 15 in terms of the direction in which the process cartridge 15 is inserted into the apparatus main assembly 27, and is located slightly above the base portion of the above described first guiding portion 15a, extending in the cartridge insertion direction. The engaging member

20n is an integral part of the front end cover 20, and projects in the cartridge insertion direction beyond the front end of the process cartridge 15 in terms of the cartridge insertion direction. The front end of the process cartridge 15 is such an end of the process cartridge 15 that will be located at the front end when the process cartridge 15 is inserted into the apparatus main assembly 27. The top surface of the process cartridge 15 is such a surface of the process cartridge 15 that will be facing upward when the process cartridge 15 is inserted into the apparatus main assembly 27. The first guiding portion 15a comprises: two sections: an integral part of the front end cover 20 and an integral part of the cleaning means holding frame 13. Further, the process cartridge 15 is provided with a second guiding portion 20g, which is at the bottom right corner of the front end of the process cartridge 15 in terms of the direction in which the process cartridge 15 is inserted into the apparatus main assembly 27. The second guiding portion 20g has a projection 20g1, and the projection 20g1 has a slanted surface 20g3, which is on the underside of the projection 20g1. Further, the process cartridge 15 is provided with a third guiding portion 19g, which is located at the bottom right corner of the rear end of the process cartridge 15 in terms of the direction in which the process

cartridge 15 is inserted into the apparatus main assembly 27. The third guiding portion 19g is slightly below the bottom surface of the process cartridge 15. The axial line of the third guiding portion 19g coincides with the axial line of the projection 20g of the second guiding portion 20g, and is parallel to the axial line of the photosensitive drum 11. The third guiding member 19g is an integral part of the rear end cover 19.

In order to insert the process cartridge 15 into the image forming apparatus main assembly 27, first, the door 60 located at the front of the image forming apparatus main assembly 27 (which corresponds to the non-driven end of the photosensitive drum 11 in terms of the longitudinal direction) is opened as shown in Figure 43(M). Then, the process cartridge 15 is lifted, with the first handle on the top surface of the process cartridge 15 grasped by one hand of an operator, and the second handle at the rear end of the process cartridge 15 grasped by the other hand, and is inserted into the cartridge mounting portion 71 through the opening 100a. Next, referring to Figure 40, the first guiding portion 15a of the process cartridge 15 is rested on the stationary guide 72 on the apparatus main assembly side, and the second guiding portion 20g of the process cartridge 15 is fitted in the second guiding groove 73b on the

apparatus main assembly side. Then, the process cartridge 15 is pushed straight (toward the back side of the paper on which Figure 40 is drawn; the direction indicated by an arrow mark in Figures 43(M) and 43(N)) into the image forming apparatus main assembly 27 in the direction parallel to the longitudinal direction of the photosensitive drum 11.

The stationary guide 72 on the apparatus main assembly side for supporting the first guiding portion 15a of the process cartridge 15 while moving the process cartridge 15 in the image forming apparatus main assembly 27 in the direction parallel to the electrophotographic photosensitive drum 11 does not extend all the way to the front end of the process cartridge 15, creating a trap portion 72a between the front end of the stationary guide 72 and the front wall of the cartridge mounting portion 71. Thus, as the first guiding portion 15a slides inward on the stationary guide 72 on the apparatus main assembly side, it arrives at the trap portion 72a and extends from the end of the stationary guide 72 over the trap portion 72a, as shown in Figure 44(H). Next, referring to Figure 44(I), before the first guiding portion 15a falls off from the stationary guide 72, the engaging member 20n located at the front end of the process cartridge 15 in terms of the cartridge insertion direction slides into the cam groove 78a of

the vertical movement lever 78. Next, referring to Figures 44(I) and 44(J), as the process cartridge 15 is pushed further into the cartridge mounting portion 71, the first guiding portion 15a becomes disengaged from the stationary guide 72 on the apparatus main assembly side. As a result, the process cartridge 15 is partially supported by the vertical movement lever 78; the engaging member 20n of the process cartridge 15 is supported by the vertical movement lever 78.

At the same time as the first guiding portion 15a of the process cartridge 15 is rested on the stationary guide 72 on the apparatus main assembly side, the second guiding portion 20g at the bottom right corner of the front end of the process cartridge 15 is rested on the guide 73. Thereafter, as the process cartridge 15 is pushed further inward of the cartridge mounting portion 71, the second guiding portion 20g moves inward while sliding on the guide 73, and the third guiding portion 19g at the bottom right corner of the rear end of the process cartridge 15 in terms of the cartridge insertion direction engages into the second guiding groove 73b before the projection 20g1 of the second guiding portion 20g reaches the cylindrical member 53. The third guiding portion 19g is provided with the slanted surface 19g1, which is located at the front end in terms of the cartridge insertion direction, as shown in Figure 6,

and therefore, the third guiding portion 19g smoothly enters the second guiding groove 73b. As a result, the bottom right of the rear portion of the process cartridge 15 in terms of the cartridge insertion direction is supported by the second guiding groove 73b, in the cartridge mounting portion 71, and the first guiding portion 15a at the top left of the front end of the process cartridge 15 in terms of the cartridge insertion direction is supported by the stationary guide 72 on the apparatus main assembly side. As the process cartridge 15 is further inserted, the projection 20g1 at the bottom right of the front end of the process cartridge 15 is inserted into the hole 53a of the cylindrical member 53 at the same time as the engaging member 20n engages into the cam groove 78a of the vertical movement lever 78. Since the position of the axial line of the hole 53a of the cylindrical member 53 is higher than that of the axial line of the projection 20g1 while the projection 20g1 is guided by the first guiding groove 73a, the right front of the process cartridge 15 is lifted as the engaging member 20g enters the hole 53a. The bottom side of the projection 20g1 has the slanted surface 20g3, which is located at the front end in terms of the cartridge insertion direction, as shown in Figure 6, and therefore, the projection 20g1 smoothly slides into the hole 53a of the cylindrical

member 53.

Immediately after the projection 20g1 fits into the hole 53a of the cylindrical member 53 and the engaging member 20n engages into the cam groove 78a of the vertical movement lever 78, the first guiding portion 15a is directly above the trap portion 72a, and further, the third guiding portion 19g is resting in the second guiding groove 73b; in other words, the process cartridge 15 is supported at three points.

When the external lever 77 is at the position shown in Figure 40, it is retained by an unshown notch. As the external lever 77 is rotated in the direction indicated by an arrow mark B, the shaft 74 rotates with the external lever 77, causing the inside lever 78, or the vertical movement lever, to rotate in the direction to lower the cam groove 78a. As a result, the engaging member side of the process cartridge 15 descends, the process cartridge 15 pivoting about the projection 20g1 in the hole 53a of the cylindrical portion 53 and the third guiding portion 19g supported by the second guiding groove 73b, and the engaging member 20n rested in the cam groove 78a moving in the cam groove 78a, until the bearing members 22a and 22b which double as positioning members fit into the positioning recesses 75a and 75b, respectively, of the apparatus main assembly 27. The mounting of the process cartridge 15

into the apparatus main assembly 27 ends as the external lever 77 becomes horizontal (Figure 41).

At this time, referring to Figure 46, the manner in which the process cartridge 15 is lowered by the vertical movement lever 78 will be described.

Immediately after the process cartridge 15 is inserted straight all the away into the cartridge mounting portion 71 through the opening 100a, the process cartridge 15 is at a high position (H) (indicated in Figure 46 by the process cartridge contour designated by a referential code 15(H)). At the position (H), the process cartridge 15(H) is supported by the vertical movement lever 78, by the engaging member 20n, and also is supported by the cylindrical portion 53, by the projection 20g1 in the hole 53a of the cylindrical portion 53. Further, the process cartridge 15(H) is supported by the second guiding groove 73b, by the third guiding portion 19g.

As the cam groove 78a side of the vertical movement lever 78 descends, the engaging member 20n also descends. During this descent, the process cartridge 15 pivots about the axial line of the projection 20g1 and the axial line of the third guiding portion 19g, which coincide with each other, and the engaging member 20n descends while sliding on the bottom 78b of the cam groove 78a toward the shaft 74, due to the self-weight of the process cartridge.

When the engaging member side of the process cartridge 15 is at the mid point of its descent, the axial line of the engaging member 20n is in the plane connecting the axial lines of the third guiding portion 19g and shaft 74, and the engaging member 20n is closest to the shaft 74 within the moving range of the engaging member 20n. The profile of the bottom of the cam groove 78a is rendered so that while the engaging member 20n is descending from the position at which the vertical movement lever 78 is at a position 78(H) (indicated by the vertical movement lever contour designated by a referential code 78(H)), the axial line of the engaging member 20n remains in the plane CL connecting the axial lines of the engaging member 20n and shaft 74. As the cam groove 78a side of the vertical movement lever 78 further descends, the engaging member 20n slides on the bottom 78b of the cam groove 78 in the direction to move away from the shaft 74. Before the engaging member 20n reaches the outward wall 78c of the cam groove 78a, which has a cylindrical curvature and is connected to the right end of the bottom 78b, the bearing member 22a and 22b of process cartridge 15 fit into the positioning recesses 75a and 75b. Thereafter, the engaging member 20n remains stationary. As the cam groove 78a side of the vertical movement lever 78 further descends, the outward wall 78c of the cam groove 78a, which has a

cylindrical curvature, moves without coming in contact with the engaging member 20n, and the opening portion 78d of the cam groove 78a comes to the position of the engaging member 20n. The axial lines of the cylindrical curvatures of the outward and inward walls 78c and 78e of the cam groove 78a coincide with the axial line of the shaft 74. The distance between the outward and inward walls 78c and 78e of the cam groove 78a is greater than the diameter of the engaging member 20n. The space between the outward and inward walls 78c and 78e opens upward, forming the opening 78d.

As the process cartridge 15 is inserted straight all the way into the cartridge mounting portion 71, the first and second couplings 105a and 106a, as driving force receiving members, on the process cartridge side, engage with the first and second couplings 103 and 104, as driving force transmitting members, on the apparatus main assembly side, respectively, although they sometimes fail to engage. Even if they fail to engage, as the couplings on the apparatus main assembly side are driven, they advance and instantly engage with the coupling members on the process cartridge side, because the couplings on the apparatus main assembly side are kept pressured by the force from the aforementioned resilient member.

As the first coupling 103 on the apparatus

main assembly side and the first coupling 105a on the process cartridge side are rotationally driven by an unshown driving force source of the apparatus main assembly 27, they become aligned with each other; in other words, their axial lines become aligned with each other. As a result, the photosensitive drum 11 becomes aligned with the first coupling 103 on the apparatus main assembly side. The distance the axial line of the coupling 106a of the process cartridge side moves to become aligned with the axial line of the first coupling 103 on the apparatus main assembly side is such that displaces the bearing member 22b of the process cartridge 16 approximately 100 microns to 1 mm from the position at which the bearing member 22b has settled in the recess 76b. While the process cartridge 15 is driven, it is supported by the positioning recess 75b at the rear side in terms of the cartridge insertion direction, cylindrical portion 53, and the first coupling 103 on the apparatus main assembly side which is in engagement with the first coupling 105a on the process cartridge side. As described before, even if the axial line of the second coupling 104 on the apparatus main assembly side is not in alignment with that of the second coupling 106a on the process cartridge side, driving force can be transmitted without any problem.

After the descending process cartridge 15 has

settled in the cartridge mounting portion 71, it remains supported by the positioning recess 75a, hole 53a of the cylindrical member 53, and positioning recess 75b, on the apparatus main assembly side.

In other words, the positioning members (shaft portions 22a1 and bearing member 22b) of the process cartridge 15 remain engaged in the positioning recesses 75a and 75b on the apparatus main assembly side, and the projection 20g1 of the process cartridge 15 remains engaged in the hole 53a.

As the external lever 77 in the state shown in Figure 41 is rotated in the direction indicated by an arrow mark C, the shaft 74 rotates in the same direction, causing the vertical movement lever 78 to move upward. As the vertical movement lever 78 moves upward, the engaging member 20n at the top left of the front end of the process cartridge 15 in terms of the cartridge insertion direction is lifted by the cam groove 78a. As a result, the projection 20g1 at the bottom right corner of the front end of the process cartridge 15 in terms of the cartridge insertion direction rotates in the cylindrical portion 53 of the apparatus main assembly 27, the left side of the process cartridge 15 as seen from the rear end in terms of the cartridge insertion direction is lifted, the shaft 22a1 moves upward slightly away from the positioning recess 75a, the bearing member 22b moves

upward slightly away from the positioning recess 75b, and the third guiding portion 19g at the bottom right corner of the rear end of the process cartridge 15 in terms of the cartridge insertion direction descends and is supported by the second guiding groove 73b. In this state, that is, while the projection 20g1 of the process cartridge 15 is supported by the cylindrical portion 53, and the third guiding portion 19g of the process cartridge 15 is supported by the third guiding groove 73b, the process cartridge 15 pivots about the axial line of the projection 20g1 and the axial line of the cylindrical bottom end of the third guiding portion 19g, causing the engaging member 20n to move upward. As a result, the state shown in Figure 40 is realized. In this state, the first guiding portion 15a at the top left of the front end of the process cartridge 15 in terms of the cartridge insertion direction, which has passed upward through the trap portion 72a during the above described pivoting of the process cartridge 15, is in a position from which it can be smoothly slid onto the stationary guide 72 on the apparatus main assembly side. In this state shown in Figure 40, the process cartridge 15 can be pulled toward the front side of the apparatus main assembly, gasping the second handle 29 with one hand, the engaging member 20n at the top left corner of the front end of the process cartridge 15 in terms of the

cartridge insertion direction slides into the cam groove 78a, that is, the portion which catches the engaging member 20n, by a short distance, and the projection 20g1 at the bottom right of the front end of the process cartridge 15 in terms of the cartridge insertion direction moves in the direction to disengage from the cylindrical portion 53. At this point in the cartridge removing operation, the first guiding portion 15a at the top left corner of the front end of the process cartridge 15 in terms of the cartridge insertion direction has already passed upward through the trap portion 72a. Therefore, as the process cartridge 15 is pulled toward the front side of the apparatus main assembly, the engaging member 20n in the form of a pin, at the top left corner of the front end of the process cartridge 15 in terms of the cartridge insertion direction disengages from the cam groove 78a after the first guiding portion 15a becomes fully rested on the stationary guide 72 on the apparatus main assembly side. At approximately the same time, the projection 20g1 at the bottom right corner of the front end of the process cartridge 15 in terms of the cartridge insertion direction disengages from the cylindrical portion 53, and the second and third guiding portions 19g and 20g on the right side of the process cartridge 15 as seen from the front side of the apparatus main

assembly 27 are rested on the first and second guiding grooves 73a and 73b. As the process cartridge 15 is pulled further toward the front side of the apparatus main assembly 27, the first guiding portion 15a slides on the stationary guide 72 on the apparatus main assembly side, and the second and third guiding portions 19g and 20g slide on the guide 73. Eventually, the third guiding portion 19g disengages first from the guide 73 as it comes out of the cartridge mounting portion 71 through the opening 100a. Then, as the process cartridge 15 is pulled further toward the front side of the apparatus main assembly 27 while the process cartridge 15 is supported with the use of the second handle 29, the first guiding portion 15a moves to the rear end of the stationary guide 72 on the apparatus main assembly side in terms of the cartridge insertion direction, and the second guiding portion 20g moves to the rear end of the stationary guide 73b of the apparatus main assembly side in terms of the cartridge insertion direction. In this state, the process cartridge 15 can be pulled straight out of the cartridge mounting portion 71 through the opening 100a. As the process cartridge 15 is pulled out through the opening 100a, the first and second guiding portions 15a and 20g disengage from the rear ends of the stationary guides 72 and 73b, respectively, on the apparatus main

assembly side in terms of the cartridge insertion direction, toward the front end of the apparatus main assembly 27.

The guides on the apparatus main assembly side may be provided with a plurality of trap portions, and the process cartridge side may be provided with a plurality of guiding portions. For example, Figure 45 is a plan view of the process cartridge and image forming apparatus main assembly in another embodiment of the present invention, for showing the manner in which the process cartridge is mounted into the apparatus main assembly. In Figure 45, the trap portion 72b is located between the front and rear ends of the stationary guide 72, so that the guiding portion 15b at the rear end of the process cartridge 15 aligns with the trap portion 72b at the same time as the first guiding portion 15a aligns with the trap portion 72a.

Since a structural arrangement is made so that the process cartridge 15 is mounted into or dismounted from the apparatus main assembly 27 as described above, while paper as recording medium is conveyed through the image forming apparatus, in other words, while driving force is applied to rotate the photosensitive drum 11 in the clockwise direction, the projection 20g1 fitting in the cylindrical portion 53 prevents the process cartridge 15 from pivoting, and

therefore, the process cartridge 15 is kept in the proper attitude. In other words, the member, about the axial line of which the process cartridge 15 pivots when the process cartridge 15 is mounted into or dismounted from the apparatus main assembly 27, also doubles as a member for preventing the process cartridge 15 from pivoting while paper is conveyed through the apparatus main assembly 27. Therefore, the member is more stable as the pivot about which the process cartridge 15 rotates.

According to the present invention, all that is necessary in order to mount a process cartridge into an image forming apparatus is to push the process cartridge into the image forming apparatus main assembly in the horizontal direction, and move a lever to a predetermined position. In other words, the operation for inserting the process cartridge straight into the apparatus main assembly is the only operation in which a process cartridge must be directly held by an operator. Therefore, even if the weight of a process cartridge increases as an image forming apparatus is increased in size, the process cartridge can be easily handled.

Further, a process cartridge can be accurately positioned simply by operating a lever. Therefore, not only can operational efficiency be improved, but also the accuracy with which a process

cartridge is positioned is improved.

Further, a process cartridge can be taken out of an image forming apparatus simply by pulling the process cartridge toward the front side of the image forming apparatus after operating a lever. Therefore, even a large process cartridge can be easily dismounted from an image forming apparatus.

Further, the first and second guiding grooves for supporting a process cartridge from below are positioned at the bottom of the developer holding frame, sufficiently away from the photosensitive drum. Therefore, the axial line of the photosensitive drum follows a virtually vertical cylindrical curvature. In addition, the engaging member in the form of a pin, of a process cartridge is inserted into the cam groove with which a vertical movement level is provided. In other words, the means for vertically moving a process cartridge is simple in structure, and the weight of a process cartridge which rests on the means for vertically moving a process cartridge directly applies to a process cartridge controlling lever (external lever 77) without going through a linking mechanism, enabling an operator to virtually directly feel the state of the process cartridge. Therefore, the operator can lift or lower the process cartridge at an appropriate speed.

The embodiments of the present invention is

summarized as follows.

1. A process cartridge (15) detachably mountable to a main assembly (27) of an electrophotographic image forming apparatus, said process cartridge (15) comprising:

a cartridge (15) frame;

an electrophotographic photosensitive drum (11) ;

a charging member (12) for electrically charging said photosensitive drum (11) ;

a developing member (developing roller 18) for developing an electrostatic latent image formed on said photosensitive drum (11) ;

a developer accommodating portion (16h) for accommodating a developer to be used for developing the electrostatic latent image by said developing member (developing roller 18) ;

an engaging member (20n) for being supported by a receiving portion (cam groove 78a) of a movable member (lever 78) provided in the main assembly (27) of said apparatus when said engaging member (20n) is in the main assembly (27) of said apparatus, wherein said engaging member (20n) is provided on a portion of said cartrige frame which takes an upper position when said process cartridge (15) is inserted into the main assembly (27) of the apparatus in a longitudinal direction thereof, at such a position as takes a

downstream end position in a direction of insertion of said cartridge (15) into the main assembly (27) of said apparatus;

a first guide portion (15a) provided on a portion of said cartridge (15) frame which takes an upper position when said cartridge (15) is inserted into the main assembly (27) of said apparatus in the longitudinal direction of said photosensitive drum (11), at such a position as takes a downstream position with respect to the direction of insertion of said cartridge (15), wherein said first guide portion (15a) is guided by a main assembly fixed guide (72) provided in the main assembly (27) of said apparatus when said cartridge (15) is being inserted into the main assembly (27) of said apparatus;

a second guide portion (20g) provided on a portion of said cartridge (15) frame which takes a lower position when said cartridge (15) is inserted into the main assembly (27) of said apparatus in the longitudinal direction of said photosensitive drum (11), at such a position as takes a downstream position with respect to the insertion of said cartridge (15), wherein said second guide portion (20g) is guided by a first guide recess (73a) provided in the main assembly (27) of apparatus when said cartridge (15) is inserted into the main assembly (27) of the apparatus;

a third guiding portion provided on a portion of said cartridge (15) frame which takes a lower position when said cartridge (15) is inserted into the main assembly (27) of the apparatus in the longitudinal direction of said photosensitive drum (11), at such a position as takes an upstream position in the direction of insertion of said cartridge (15), wherein said third guide portion (19g) is guided by a second guide recess (73b) provided in the main assembly (27) of the apparatus when said cartridge (15) is inserted into the main assembly (27) of the apparatus;

a driving force receiving member (first coupling 105a) provided at a downstream end portion with respect to the direction of insertion, wherein said driving force receiving member (first coupling 105a) receives a driving force from a driving force transmitting member provided in the main assembly (27) of apparatus; and

a positioning portion (bearing member 22b) which is projected from said cartridge (15) frame toward an upstream side with respect to the direction of insertion, wherein said positioning portion (bearing member 22b) is disposed coaxially with said photosensitive drum (11), and wherein when said engaging member (20n) supported by said receiving portion (cam groove 78a) is released to permit said

cartridge (15) to lower to the mount position, said positioning portion (bearing member 22b) is supported by a positioning recess (75a) provided in the main assembly (27) of the apparatus.

2. A process cartridge (15) Paragraph 1, wherein said second guide portion (20g) and said third guide portion (19g) are provided in said cartridge (15) frame portion having said developer accommodating portion (16h), and said engaging member (20n) and said first guide portion (15a) are provided in said cartridge (15) frame portion an opposite cartridge (15) frame portion.

3. A process cartridge (15) Paragraph 1 or 2, wherein by operating a lever (77) provided in the main assembly (27) of the apparatus, the movable member (lever 78) is lowered, and said engaging member (20n) supported by said receiving portion (cam groove 78a) is released, so that cartridge (15) lowers to the mount position from the position in which it is inserted into the main assembly (27) of apparatus.

4. A process cartridge (15) Paragraph 3, wherein when the cartridge (15) lowers, said second guide portion (20g) is in engagement with said first guide recess (73a), and said third guide portion (19g) is in engagement with said second guide recess (73b), and said cartridge (15) lowers by rotation about said

second guide portion (20g) and a third guide portion (19g) to the mount position.

5. A process cartridge (15) according to Paragraph 1, 2 or 3, wherein said engaging member (20n) is projected upworldly beyond a top side of said cartridge (15) frame portion and is projected in the direction of insertion beyond a leading end surface of said cartridge (15) frame portion, wherein said leading end surface is a surface which takes a leading position when said cartridge (15) is inserted into the main assembly (27) of the apparatus, wherein said top side is a side which takes a top position when said cartridge (15) is inserted into the main assembly (27) of the apparatus.

6. A process cartridge (15) Paragraph 5, wherein said engaging member (20n) is integrally formed with a leading end cover (20) constituting said cartridge (15) frame, and wherein said engaging member (20n) has a cylindrical configuration, wherein said leading end cover (20) takes a leading end position when said cartridge (15) is inserted into the main assembly (27) of the apparatus.

7. A process cartridge (15) according to Paragraph 1, 2 or 3, wherein said first guide portion (15a) is projected beyond in a side surface of said cartridge (15) frame portion in a direction crossing with the direction of insertion, and said first guide

portion (15a) has a horizontal projected portion (15a1) which is substantially parallel with a top side of said cartridge (15) frame portion and a downward projected portion (15a2) which projects downwardly from said horizontal projected portion (15a1), said downward projected portion (15a2) has a bottom end for being guided by said guide fixed in the main assembly (27) .

8. A process cartridge (15) Paragraph 7, wherein said first guide portion (15a) is integrally formed with a leading end cover (20) and a cleaning frame (13) which constitute said cartridge (15) frame, wherein the leading end cover (20) takes a leading end position when said cartridge (15) is inserted into the main assembly (27) of the apparatus.

9. A process cartridge (15) according to Paragraph 1, 2 or 3, wherein said second guide portion (20g) is projected downwardly from a bottom side of said cartridge (15) frame portion, and a leading end portion (projection 20g1) of said second guide portion (20g) is engageable with a hole (53a) provided in the main assembly (27) of the apparatus, wherein the bottom side takes a bottom position when said cartridge (15) is inserted into the main assembly (27) of the apparatus.

10. A process cartridge (15) Paragraph 9,

wherein said second guide portion (20g) is formed integrally with a leading end cover (20) constituting said cartridge (15) frame, wherein the leading end cover (20) takes a leading end position when said cartridge (15) is inserted into the main assembly (27) of the apparatus.

11. A process cartridge (15) according to Paragraph 1, 2 or 3, wherein said third guide portion (19g) is projected downwardly from a bottom side of said cartridge (15) frame portion, wherein the bottom side takes a bottom position when said cartridge (15) is inserted into the main assembly (27) of the apparatus.

12. A process cartridge (15) Paragraph 11, wherein said third guide portion (19g) is formed integrally with a trailing end cover (19) constituting said cartridge (15) frame, wherein the trailing end cover (19) takes a trailing end position when said cartridge (15) is inserted into the main assembly (27) of the apparatus.

13. A process cartridge (15) according to any one of Paragraphs 1, 7, 9 and 11, wherein a top side of said cartridge (15) frame is provided with a first grip (30) for being gripped when said cartridge (15) is carried, and a training end portion of said cartridge (15) frame is provided with a second grip (29) for being gripped when said cartridge (15) is

inserted into or taken out of the main assembly (27) of the apparatus.

14. A process cartridge (15) according to any one of Paragraphs 1, 7, 9, 11 and 13, further comprising a positioning member provided at a leading end side with respect to the direction of insertion of the process cartridge (15), the positioning member extending so as to enclose said driving force receiving member (first coupling 105a), wherein a part of said positioning member is engaged with a positioning recess (75b) provided in the main assembly (27) of the apparatus to be correctly position at a mount position in the main assembly (27) of the apparatus.

15. A process cartridge (15) Paragraph 1, wherein said process cartridge (15) moves from the mount position through 100μ - 1mm in a direction crossing with the direction of the insertion, when said driving force receiving member (first coupling 105a) is centered relative to said driving force transmitting member by receiving the driving force from said driving force transmitting member.

16. An electrophotographic image forming apparatus for forming an image on the recording material, to which a process cartridge (15) is detachably mountable, said apparatus comprising:

(a) a lever (77) ;

(b) a movable member (lever 78) interrelated with said lever (77), said movable member (lever 78) having a receiving portion (cam groove 78a) ;

(c) a fixed guide (72) fixed in the main assembly (27) ;

(d) a first guide recess (73a) ;

(e) a second guide recess (73b) ;

(f) a positioning recess (75) provided in the main assembly (27) ;

(g) a driving force transmitting member;

(h) a process cartridge (15) mounting portion (71) for detachably mountable said process cartridge (15), said cartridge (15) including;

a cartridge (15) frame;

an electrophotographic photosensitive drum (11) ;

a charging member (12) for electrically charging said photosensitive drum (11) ;

a developing member (developing roller 18) for developing an electrostatic latent image formed on said photosensitive drum (11) ;

a developer accommodating portion (16h) for accommodating a developer to be used for developing the electrostatic latent image by said developing member (developing roller 18) ;

an engaging member (20n) for being supported by a receiving portion (cam groove 78a) of a movable

member (lever 78) provided in the main assembly (27) of said apparatus when said engaging member (20n) is in the main assembly (27) of said apparatus, wherein said engaging member (20n) is provided on a portion of said cartrige frame which takes an upper position when said process cartridge (15) is inserted into the main assembly (27) of the apparatus in a longitudinal direction thereof, at such a position as takes a downstream end position in a direction of insertion of said cartridge (15) into the main assembly (27) of said apparatus;

a first guide portion (15a) provided on a portion of said cartridge (15) frame which takes an upper position when said cartridge (15) is inserted into the main assembly (27) of said apparatus in the longitudinal direction of said photosensitive drum (11), at such a position as takes a downstream position with respect to the direction of insertion of said cartridge (15), wherein said first guide portion (15a) is guided by a main assembly fixed guide (72) provided in the main assembly (27) of said apparatus;

a second guide portion (20g) provided on a portion of said cartridge (15) frame which takes a lower position when said cartridge (15) is inserted into the main assembly (27) of said apparatus in the longitudinal direction of said photosensitive drum (11), at such a position as takes a downstream

position with respect to the insertion of said cartridge (15), wherein said second guide portion (20g) is guided by a first guide recess (73a) provided in the main assembly (27) of apparatus when said cartridge (15) is inserted into the main assembly (27) of the apparatus;

a third guiding portion provided on a portion of said cartridge (15) frame which takes a lower position when said cartridge (15) is inserted into the main assembly (27) of the apparatus in the longitudinal direction of said photosensitive drum (11), at such a position as takes an upstream position in the direction of insertion of said cartridge (15), wherein said third guide portion (19g) is guided by a second guide recess (73b) provided in the main assembly (27) of the apparatus when said cartridge (15) is inserted into the main assembly (27) of the apparatus;

a driving force receiving member (first coupling 105a) provided at a downstream end portion with respect to the direction of insertion, wherein said driving force receiving member (first coupling 105a) receives a driving force from a driving force transmitting member provided in the main assembly (27) of apparatus; and

a positioning portion (bearing member 22b) which is projected from said cartridge (15) frame

toward an upstream side with respect to a direction of insertion, wherein said positioning portion (bearing member 22b) is disposed coaxially with said photosensitive drum (11), and wherein when said engaging member (20n) supported by said receiving portion (cam groove 78a) is released to permit said cartridge (15) to lower to the mount position, said positioning portion (bearing member 22b) is supported by a positioning recess (75b) provided in the main assembly (27) of the apparatus;

17. An apparatus according to Paragraph 16, wherein said fixed guide (72) is disposed adjacent one end of said cartridge (15) mounting portion (71) with respect to a direction crossing with the direction of insertion, and is extended in the direction of insertion from an inlet side for insertion of the process cartridge (15) to the cartridge (15) mounting portion (71) toward a rear side, wherein said fixed guide (72) is provided with a recess engageable with said first guide portion (15a) .

18. An apparatus according to Paragraph 16 or 17, wherein said first guide recess (73a) and said second guide recess (73b) are disposed adjacent the other end portion of said cartridge (15) mounting portion (71) with respect to a direction crossing with the direction of insertion, wherein said second guide

recess (73b) is disposed adjacent an entrance portion (opening 100a) of said mounting portion, and said first guide recess (73a) is disposed at a rear side of said mounting portion, and wherein a flat guide portion (73c) is provided between said first guide recess (73a) said second guide recess (73b) .

19. A cartridge (15) mounting method for mounting a process cartridge (15) to a main assembly (27) of an electrophotographic image forming apparatus, said method comprising:

(a) a step of providing in the main assembly (27) of said electrophotographic image forming apparatus a lever (77),

a movable member (lever 78) interrelated with said lever (77) and having a receiving portion (cam groove 78a)

a fixed guide (72),

a first guide recess (73a),

a second guide recess (73b),

a positioning recess (75) and

a driving force transmitting member;

(b) a step of providing in the process cartridge (15),

a cartridge (15) frame,

an electrophotographic photosensitive drum (11),

a charging member (12) for electrically

charging said photosensitive drum (11),

a developing member (developing roller 18) for developing an electrostatic latent image formed on said photosensitive drum (11),

a developer accommodating portion (16h) for accommodating a developer to be used for developing the electrostatic latent image by said developing member (developing roller 18),

an engaging member (20n) for being supported by said receiving portion (cam groove 78a) when said engaging member (20n) is in the main assembly (27) of said apparatus, wherein said engaging member (20n) is provided on a portion of said cartrige frame which takes an upper position when said process cartridge (15) is inserted into the main assembly (27) of the apparatus in a longitudinal direction thereof, at such a position as takes a downstream end position in a direction of insertion of said cartridge (15) into the main assembly (27) of said apparatus;

a first guide portion (15a) provided on a portion of said cartridge (15) frame which takes an upper position when said cartridge (15) is inserted into the main assembly (27) of said apparatus in the longitudinal direction of said photosensitive drum (11), at such a position as takes a downstream position with respect to the direction of insertion of said cartridge (15), wherein said first guide portion

(15a) is guided by said fixed guide (72) when said cartridge (15) is being inserted into the main assembly (27) of said apparatus;

a second guide portion (20g) provided on a portion of said cartridge (15) frame which takes a lower position when said cartridge (15) is inserted into the main assembly (27) of said apparatus in the longitudinal direction of said photosensitive drum (11), at such a position as takes a downstream position with respect to the insertion of said cartridge (15), wherein said second guide portion (20g) is guided by a first guide recess (73a) said cartridge (15) is inserted into the main assembly (27) of the apparatus,

a third guiding portion provided on a portion of said cartridge (15) frame which takes a lower position when said cartridge (15) is inserted into the main assembly (27) of the apparatus in the longitudinal direction of said photosensitive drum (11), at such a position as takes an upstream position in the direction of insertion of said cartridge (15), wherein said third guide portion (19g) is guided by a second guide recess (73b) when said cartridge (15) is inserted into the main assembly (27) of the apparatus,

a driving force receiving member (first coupling 105a) provided at a downstream leading end

portion with respect to the direction of insertion, wherein said driving force receiving member (first coupling 105a) receives a driving force from a driving force transmitting member, and

a positioning portion (bearing member 22b) which is projected from said cartridge (15) frame toward an upstream side with respect to a direction of insertion, wherein said positioning portion (bearing member 22b) is disposed coaxially with said photosensitive drum (11), and wherein when said engaging member (20n) supported by said receiving portion (cam groove 78a) is released to permit said cartridge (15) to lower to the mount position, said positioning portion (bearing member 22b) is supported by a positioning recess (75a) provided in the main assembly (27) of the apparatus; and

(c) a step of inserting said process cartridge (15) into the main assembly (27) of said apparatus with said first guide portion (15a) being guided by said fixed guide (72), with said second guide portion (20g) being guided by said first guide recess (73a), and with said second guide portion (20g) being guided by said second guide recess (73b) ; causing said engaging member (20n) to be supported by said receiving portion (cam groove 78a) ; and thereafter, releasing said engaging member (20n) from said receiving portion (cam groove 78a) by operating

said movable member (lever 78), so that cartridge (15) is let fall to the mount position.

According to the embodiments described in the foregoing, the process cartridge can be mounted into or demounted out of the main assembly of the image forming apparatus in the longitudinal direction of the electrophotographic photosensitive drum, at the front of the main assembly, and the process cartridge itself can be pivoted by the raising and lowering means, so that the mounting and demounting operativity is improved even in the case of the process cartridges which is relatively heavy as a result of speed-up of the image forming operation of the electrophotographic image forming apparatus.

In addition, when the process cartridge is let fall by its weight in the image forming apparatus, the positioning member (shaft 22a1, bearing member 22b) provided coaxially with the electrophotographic photosensitive drum 11 is supported by the positioning recesses (75a and 75b) provided in the main assembly. By this, the cartridge 15 is correctly positioned at the mount position by the opposite end portions of the photosensitive drum 11.

As described in the foregoing, according to the present invention, the process cartridge can be mounted to the mount position by inserting the process cartridge into the main assembly of the apparatus in

the longitudinal direction of the photosensitive drum and then letting it fall.

According to the present invention, therefore, the mounting and demounting operativity is improved relative to the main assembly of the apparatus.

According to the present invention, the positional accuracy of the process cartridge in the main assembly of the apparatus is improved.

While the invention has been described with reference to the structures disclosed herein, it is not confined to the details set forth and this application is intended to cover such modifications or changes as may come within the purposes of the improvements or the scope of the following claims.